

Division of Aquatic and Wildlife Resources

Guam Department of Agriculture



Annual Report Fiscal Year 1991

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'91

ANNUAL REPORT FISCAL YEAR 1991

DIVISION OF AQUATIC AND WILDLIFE RESOURCES
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PERIOD COVERED:
October 1, 1990 to September 30, 1991

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Wildlife Inspector George Phocas, Division of Law Enforcement, U.S. Fish and Wildlife Service, U.S. Department of the Interior.

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JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: C-1

JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs

PERIOD COVERED: October 1, 1990 to September 30, 1991

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.
2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.
3. Administer all personnel matters including recruitment of off-island staff.
4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division experienced several staff changes during the year. Celestino Aguon was transferred to the Endangered Species Program to handle the Marianas Crow recovery effort, but he also continues to handle game management pending the recruitment of a new Game Management Biologist. Marvin Aguilar was promoted from Biological Aide to Biologist I and assigned to the new locally-funded Technical Assistance Program. John Borja was hired as a Fisheries Technician I, Betwin Alokua was hired as a Wildlife Technician I, and Ben Reyes and Mary Taylor were hired as Wildlife Biological Aides.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY '90 under its various federal programs and submitted them to the U.S. Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY '92. This documentation included annual Project Agreements for the various Fish and Wildlife Investigations and endangered species activities that the Division conducts. These project documents received federal approval during the reporting period.

In addition to Federal Aid Program documentation, staff devoted considerable effort to preparing various project proposals and budget requests for Brown Tree Snake research funds.

Fiscal and budgetary activities included monthly preparation and submission of reimbursement vouchers for our various Federal Aid programs and coordination with the Government Accounting and Budget Offices to ensure fiscal integrity.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military.

A budget plan prepared during FY '90 that proposed a significant increase in the level of local funding for the Division's programs was approved, resulting in the creation of several new positions and the local funding of approximately 50% of the Division's administrative costs.

The Chief served on the Department's Land Lease Approving Committee, which must review and approve all proposed leases of government land for agricultural purposes. He was also appointed to serve as a member of the Territorial Land Use Commission. In addition, the Chief also served as the Government of Guam's representative to the Western Pacific Regional Fisheries Management Council.

Division staff made a number of off-island trips related to Federal Aid programs.

A Federal Aid Coordinators Conference (FACC) held in Juneau, Alaska, was attended by Chief Rufo Lujan, Assistant Chief Robert Anderson, and Fisheries Supervisor Gerry Davis.

Division Chief Rufo J. Lujan represented the Government of Guam at the Western Pacific Regional Fisheries Management Council, which met in Honolulu in December, February and in Kona in August. Mr. Lujan also represented Guam at a meeting of the South Pacific Applied Geotechnical Commission (SOPAC) held in Kiribati in October. Other travel included a meeting in Honolulu in November on Critical Habitat and in Washington D.C. in June on the brown tree snake. In addition, Mr. Lujan attended the FACC in Juneau and the joint fisheries and wildlife conferences on Saipan and Rota.

Assistant Chief Robert D. Anderson traveled to Washington D.C. in October to attend the first National Federal Aid Coordinators Conference. He also attended the joint wildlife conference on Rota.

Public Information Officer Lillian Mariano attended the joint fisheries and wildlife conferences on Saipan and Rota.

Fisheries Section Supervisor Gerry Davis attended the Western Pacific Region Fisheries Management Bottomfish and Pelagic Plan Monitoring Team meetings in Hawaii held in November and May. He also attended the joint fisheries conference on Saipan. In addition Mr. Davis attended an Aquatic Education Conference in Port Angeles, Washington in July.

Fishery Biologist Rob Myers attended the Western Pacific Region Fisheries Management Bottomfish and Pelagic Plan Monitoring Team meetings in Hawaii held in November and May. He also attended the joint fisheries conference on Saipan. In addition Mr. Myers participated in a Creel Census Workshop held in Honolulu, Hawaii in July.

Fishery Biologist Tim Sherwood attended the joint fisheries conference on Saipan in November. In addition, he participated in a conference on fisheries data processing held at the National Marine Fisheries Service Laboratory in Honolulu.

Fishery Biologists Wayne Kruckenberg, Rebecca Hensley, and Gretchen Grimm and Fishery Technician Glenn San Nicolas attended the joint fisheries conference on Saipan in November.

Wildlife Section Supervisor Robert Beck traveled to Rota in January to release captive-bred Guam Rails as a part of the effort to establish an experimental population in the wild on Rota. He made several later trips to monitor the success of the release and also to attend the joint wildlife conference on Rota in April.

Wildlife Technician, Herman Muna, traveled to Rota in January to release captive-bred Guam Rails as a part of the effort to establish an experimental population in the wild on Rota. He made several later trips to monitor the success of the release and also to attend the joint wildlife conference on Rota in April.

Wildlife Biologist Mike McCoid attended the joint wildlife conference on Rota in April. He also participated in the Pacific Science Congress in Honolulu in May, where he presented a paper on the brown tree snake. In addition, he traveled to Palau to attend a conference of Pacific port operators and stevedoring companies, at which he gave a talk on the brown tree snake threat to the Pacific islands.

Wildlife Biologist Gary Wiles attended the joint wildlife conference on Rota in April. He also traveled to Hilo, Hawaii in February to attend a wildlife disease workshop sponsored by the U.S. Fish and Wildlife Service.

Wildlife Biologist Celestino Aguon attended the joint wildlife conference on Rota in April. He also traveled to Hilo, Hawaii in February to attend a wildlife disease workshop sponsored by the U.S. Fish and Wildlife Service. While on this trip he also visited the captive breeding facility for the Hawaiian Crow at Olinda, Maui.

Conservation Officer III Johnny Villagomez and Wildlife Technicians Jesse Guerrero, Robert Cruz, and Biological Aide Derrick Kowalski attended the joint wildlife conference on Rota in April.

The Division hosted a number of off-island visitors during the year. Marvin Plenart, Dave McMullin, Robert Smith, Ernie Kosaka, Andy Yuen, John Ford, Karen Rossa, Karen Evans, Chip Demarest, Tom Fritts, John Engbring, Gordon Rodda, Lisa Close, Craig Clark, Tom Riley, Carroll Cox, Bill Dusel and George Phocas, all of the U.S. Fish and Wildlife Service; Dave Hamm and Joe Koczur of the National Marine Fisheries Service; Sandra Banack of Yale University; Paul Breese and the Brown Tree Snake Control Group from Hawaii; Richard Bruggers, Scott Wood, Pete Savarie, and Richard Curnow, all of the USDA/APHIS Science and Technology Program; Gary Oldenburg and Tim Ohashi of the USDA/APHIS Animal Damage Control Program, two separate groups from Okinawa visited to learn about the Guam Rail Recovery Program and to study its applicability to their desires to initiate a similar program for the recovery of the Yambaru Quina (Okinawa Rail), Kenneth Kardong of Washington State University.

In addition, numerous representatives of the CNMI Department of Natural Resources visited during the year to discuss subjects of mutual interest.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: C-2

JOB NO.: 1

PROJECT TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

PERIOD COVERED: October 1, 1990 to September 30, 1991

BACKGROUND

The Division of Aquatic & Wildlife Resources' (DAWR) professional staff devoted a significant percentage of their time and effort to technical assistance. The rapid pace of development on the island is requiring increasing amounts of time from the Division's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. Because of the size and complexity of some of these developments the Division's review responsibility will require a continuing commitment that could extend even beyond project completion.

In response to the increase in workload, the Division created the Technical Assistance Program as a new and separate section within the DAWR under the direct supervision of Chief of DAWR. A local appropriation has provided funding for two technical assistance staff members. In December, a Biologist I was hired to work on technical assistance and a Biologist II is currently being recruited. These positions are primarily responsible for attending and commenting on projects to the Development Review Committee. In addition, a new protocol has been adopted by the Division in regards to the review of clearing and grading permit applications. Until March of 1991, clearing and grading permits were not routed to the Division for review. It was the collaborative decision of the both the Division, the Guam Environmental Protection Agency (GEPA), and the Department of Public Works (permitting agency) to include the DAWR in the review process of Government of Guam permit applications. This additional duty is limited to the review of permits, which may impact important habitat areas.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.
2. Provide technical assistance to military and civil agencies relative to the management and protection of fish and wildlife resources.

FINDINGS

DAWR staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications were submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as part of the review process.

Various DAWR staff members actively serve as members of the following groups:

1. Ad Hoc Fisheries Council
2. Region IX Regional Response Team - Oceania
3. Development Review Committee
4. Fish and Wildlife Conservation Committee- Andersen Air Force Base
5. Water Use Master Plan Task Force
6. Western Pacific Regional Fisheries Management Council
7. Western Pacific Regional Pelagic Plan Monitoring Team
8. Western Pacific Regional Bottomfish Plan Monitoring Team
9. Exotic Species Importation Review Panel
10. Bird Aircraft Strike Hazard Committee - Andersen Air Force Base

DAWR staff have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources, and have actively consulted with various civilian and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning (BOP), GEPA, University of Guam, U.S. Army Corps of Engineers (ACOE), U.S. Fish and Wildlife Service, Western Pacific Regional Fisheries Council (WESPAC), National Marine Fisheries Service (NMFS), U.S. Navy, the U.S. Coast Guard, and U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by DAWR staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspaper, staff members participated in National Wildlife Week, Chamorro Week, Earth Week and Environmental Fair activities and gave talks to a number of civic groups, sportsman clubs, and school and university classes.

Some specific Technical Assistance activities included:

1. Representation on the DRC, which met bi-weekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is important in ensuring that the protection of Guam's fish and wildlife resources is considered in land use planning. Most recently, land and resource rights have become controversial issues, prompting the Division to question the

feasibility of certain mega-acreage proposals from a regional perspective. In review of upcoming proposals for FY '91-'92, DAWR staff have been focusing on more cumulative impact concerns such as regulated use of pesticides, degradation of watershed systems, and loss of ravine and limestone forests.

2. The Division reviewed and commented on ACOE applications for wetland fill for the Island Equipment Company, Talofofo Golf Resort and Manengon Hills Resort, to include the Manengon Hills access road, and Guam First Green Golf Course. Mitigation recommendations were included in these comments.
3. The Division provided comments to local lead agencies regarding several wetland violations (which are still pending investigation) within single family residences within the Utan area, Toto-Mongmong-Maite; adjacent to the Agana Swamp, Chalan Pago, as well as isolated areas throughout the island.
4. Division staff participated in wetlands delineation surveys/mitigation of proposed developments with both federal and local agencies for the Guam First Green Golf Course, Manengon Hills Resort, including the four-mile Manengon access road, Ordot Light Industrial Park, and the Talofofo Golf Resort.
5. The Division reviewed and commented on numerous Environmental Impact Statements/Assessments of proposed developments. These comments included recommendations for grading and clearing, erosion control, project design and orientation. These recommendations were made to reduce or eliminate impacts to the immediate and adjacent environments.
6. The Division submitted information on 19 wetlands on Guam for inclusion in the Oceania Wetland Inventory. This inventory recognizes wetlands of international importance and offers some support for the protection of these wetlands.
7. The Division reviewed and commented to the ACOE on PODCO IL2172 to place mooring buoys in Apra Harbor and the Merino Channel.
8. The Division provided comments to the USFWS pursuant to Section 7 of the Endangered Species Act for filling of wetlands in Mangilao, Guam.
9. The Division provided comments to the ACOE regarding PODCO 2176 for Guam First Green to conduct work within wetlands at Pulantat, Guam.
10. The Division provided comments to the BOP regarding Federal Consistency Application for the proposed ABC Condominium Dredging and Beach Renourishment Project.
11. The Division provided comments to local lead agencies for the construction of a Landing Craft Mechanized ramp and maintenance dredging on Cocos Island by Cocos Lagoon Development Corporation (CLDC). The Division also reviewed the masterplan modification for CLDC and submitted comments regarding their use of the Government of Guam LCM ramp in relation to impacts on the existing bird colonies through human intervention. In addition, the Division provided comments for CLDC to perform periodic maintenance dredging in the channel for an existing LCM ramp as well as obtain an after-the-fact permit for the existing ramp, to construct a concrete and wooden cabana structure, to

construct a jet ski ramp, to install five storm moorings in Cocos Lagoon, and to install a new LCM ramp at Cocos Island.

12. The Division sought information from the Director of Land Management and the Director of Parks and Recreation for lot boundaries and possible impacts to historical sites on and adjacent to the lot proposed for construction of a replacement pier in Merizo.
13. The Division reviewed and commented to local lead agencies regarding the Piti Underwater Observatory.
14. The Division offered comments, provided information to, and participated in the WESPAC and the Plan Monitoring Team on projects for bottom and pelagic fisheries. Information was provided on market sampling, biomass and stock assessment, historical and current transshipment from foreign and domestic vessels, recreational and near-water commercial vessels and public service announcements.
15. The Division reviewed and provided lengthy comments to the Territorial Seashore Protection Commission concerning the proposed dredging of a 1000' x 150' area having a maximum depth of 3' and the construction of a 1000' long by 3' high seawall at the Fujita Hotel on Tumon Bay. Corresponding comments were submitted to the ACOE, DRC, and TSPC.
16. The Division reviewed and commented on several legislative bills that would affect fish and wildlife.
17. The Division reviewed and commented on several proposals to dispose of government land through sale, exchange or lease, and made appropriate recommendations for the conservation of wildlife resources.
18. The Division met with government agencies and provided information on several occasions regarding the user conflict between mechanized craft users and fishermen in East Agana Bay.
19. The Division investigated several reports of suspected fish kills in island waters during the year.
20. The Division responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing and importation of wildlife.
21. The Division responded to many requests for information on native wildlife, particularly endangered species.
22. The Division answered numerous requests for information on hunting from both on and off-island individuals. Specific requests included information on hunting areas, hunter safety classes, firearms regulations, hunting seasons and limits, and laws and regulations.
23. Division staff provided technical assistance to numerous farmers, the Air Force, and Navy regarding pig damage. Damage control permits were issued when warranted.

24. Division staff reviewed manuscripts for other authors and for professional journals.
25. The Division provided technical assistance to the Attorney General's Office in identifying illegally taken fish and wildlife and in interpreting the laws and regulations that apply to fish and wildlife resources. In addition, the Division requested several legal opinions regarding environmental issues.
26. Division staff attended hunter safety briefings at Andersen Air Force Base and the Mangilao Community Center to provide pertinent information to hunters.
27. Division staff made numerous presentations on fish and wildlife resources at meetings of various organizations during the year.
28. Division staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting and hunting seasons, brown tree snake issues, fish and wildlife laws and regulations, endangered species, fish and wildlife importation, etc.
29. The Division reviewed and provided comments to the USFWS and Navy on the Relocatable Over The Horizon Radar Project (ROTHR). Comments emphasized the preservation of existing habitat and its importance for sustaining the existing endangered species which use this area. Additionally, alternate site were suggested which would have much less impact on native forests and endangered species.
30. Technical assistance was provided to the Marianas Fishing Derby.
31. The Division provided information to the College of Veterinary Medicine at Oregon State University regarding wildlife diseases within the boundaries of Guam's National Parks.
32. Technical assistance and logistic support were provided to Thomas Fritts and Gordon Rodda of the USFWS, Earl Campbell of the Ohio State Cooperative Fish and Wildlife Research Unit, and Manuel Santana-Bendix of the Arizona Cooperative Fish and Wildlife Research Unit for brown tree snake research, and Sandra Banack of the University of California - Berkeley for fruit bat feeding ecology.
33. The Division participated with local and federal lead agencies during National Wetland Week.
34. The Division, at the request of numerous developers, met with their representatives and consultants and other government representatives to discuss their proposed development projects and their possible impacts on endangered species, wetlands and native habitat as well as erosion, project design, etc.
35. Division staff provided technical assistance to the newly assigned USFWS Inspector concerning matters of recently established international restrictions on the importation of fruit bats to the Marianas.
36. Division staff provided technical assistance to personnel associated with the Guam rail introduction to Rota in the CNMI.

37. The Division reviewed and commented on multi-acreage proposals such as United Light Industrial Park and Pacific Garden, Marbo Cave Resort, DanDan Estates, Fadian Condominiums, Agat Nomura Resort, Agat Hill Top Resort, Guam First Green Golf Course, Takayama Golf Course, and assessed the possible impacts these developments may have on the environment. Comments included recommendations on all phases of the development that would lessen or reduce impacts to the environment.
38. A Division staff member provided technical assistance to management personnel at Cocos Island to prevent the introduction of the brown tree snake to the island.
39. A Division staff member provided technical assistance to the Republic of Palau and the USFWS by assisting in a fruit bat survey in Palau.
40. Division staff assisted other Government of Guam agencies in monitoring and inspecting conditions imposed in permits approved by the Territorial Land Use Commission and the Territorial Seashore Protection Committee. Comments on violations were submitted to the appropriate agencies for review and action.
41. The Division reviewed and submitted comments on the Federal Consistency Application for the ABC Condominium dredging and beach nourishment project.
42. In collaboration with GEPA, the Division has reviewed and submitted comments on 55 Government of Guam clearing and grading permit applications. All but four were approved with stringent conditions imposed by the Division. In addition, technical advice on wetland issues has been provided to the Development Review Section at GEPA.
43. The Division provided comments to the University of Guam Marine Laboratory regarding the proposed Tumon Bay Micro-Dredging project.
44. The Division provided comments to the U.S Fish & Wildlife Service, DRC, and Territorial Land Use Commission on mitigation/requirement for a fish passage and replacement stream at Manengon Hills Resort.
45. The Division provided input of candidate sites for conservation and marine reserves and submitted a proposal to establish a program for marine-conservation areas.
46. The Division reviewed and submitted comments to the U.S Soil Conservation Service and other local lead agencies regarding the Talofofo Watershed Project.
47. The Division reviewed and submitted comments on File No. PODCO-O 2187 to construct a pile-supported fixed pier and floating dock in the Mamaon Channel.
48. Division staff submitted various inter-departmental reports regarding wetland violations. These reports have ultimately been circulated to other lead agencies within the Government of Guam and the ACOE.
49. Division staff submitted nine Agricultural Impact Statements to the Territorial Land Use Commission, as per Government of Guam requirement for zone-change application from agricultural zones to zoning for other land uses. These

impact statements included several environmentally sensitive and controversial areas.

50. Division staff submitted over 115 position statements on various submerged land/land use issues as required by the DRC.
51. The Division provided comments to the Chairman of the Economic Development and Agricultural Committee regarding longline fishing within Guam waters.
52. The Division provided comments to the Air Force regarding the proposed placement of a Mark IVB antenna at Nimitz Hill.
53. The Division provided comments to the Naval Facilities Engineering Command regarding the installation of transmitter and receiving antennas for the DTS regional relay facility.
54. The Division provided comments to the Naval Facilities Engineering Command regarding the Screening Site Inspection at Naval Station.
55. The Division provided comments to the Government of Guam BOP regarding Federal Consistency Application for the improvement and extension of an existing jetty, and placement of floats and floating platform for Achang Bay Marina, Merizo.
56. The Division provided comments to the Regional Fisheries Training Project regarding the draft South Pacific Commission, Fisheries Human Resources Survey Guam Report.
57. Division staff submitted comments to the Legal Counsel of the Governor of Guam regarding draft regulations on the tuna longline transshipment industry.
58. The Division provided statistical data on fish and wildlife issues to the BOP and Department of Commerce as supplemental information for local annual reports.
59. The Division provided information to CSIRO Marine Laboratories regarding Guam's lobster fisheries.
60. The Division provided information to the Hian Fisheries Services, Republic of Singapore regarding sea cucumbers on Guam.
61. The Division provided comments pursuant to Section 7 of the Endangered Species Act on the Talofofo Golf Resort.
62. The Division submitted comments to the Assistant U.S. District Attorney regarding the Habitat and Reclamation Plan for the Talofofo Fish ponds.

Report was prepared by: Marvin G. Aguilar

JOB PROGRESS REPORT INFORMATION/EDUCATION PROGRAM

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: C-3

JOB NO.: 1

JOB TITLE: Public Information and Education on Guam's Fish and Wildlife Restoration and Endangered Species Programs.

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

The Division of Aquatic and Wildlife Resources (DAWR) successfully implemented for the first time ever, two fishing derbies for kids -- a two-day marine fishing derby in December 1990 for ages seven through 10, and a two-day freshwater derby in May 1991 for ages six through 12. Both events were very successful, despite the shortage of staff available to handle logistics.

As public concern for the environment continues to be more pronounced and public support for protection of Guam's natural resources against the impact of Guam's current construction boom continues to mount, the Public Awareness and Conservation Education (PACE) program has become in even greater demand particularly in the schools.

The school visitation program was revised last fiscal year to include DAWR's Conservation Officers (COs) as school program presenters. Although this has enabled DAWR to cover more schools than it was originally able to, the demand has forced the delay of various projects and activities intended to round out the Division's Information and Education program, including its yet-to-be implemented Aquatic Resource Education Program. This caused the Division to re-evaluate the needs of its PACE program in terms of additional staff support over and above the existing one-person team.

Consequently, DAWR succeeded in securing the creation of and funding for another Public Information Officer (PIO) for DAWR. The new position, which will be funded entirely by local funds, will hopefully be filled within the next fiscal year (FY92). With the addition of another information officer, the workload can then be divided to ensure that current programs are dealt with expeditiously, leaving more time to develop new and innovative programs.

Nearly 2,300 (2,292) students or 87 classes were visited this year, a slight increase over the previous year. The total number of visits does not accurately reflect the number of teacher requests received since many could not be fulfilled due to other priorities.

DAWR displays on the Brown Tree Snake and fish and wildlife poaching were shown at various public events throughout the year with an estimated 10,000 to 15,000 residents viewing the displays. Television Public Service Announcements (PSAs) continue to be aired on network and public television, and Division programs and activities continue to gain extensive media coverage.

BACKGROUND

The DAWR Public Awareness and Conservation (PACE) Program was reactivated in March 1988 following a five-year respite which resulted when a reduction in overall funding levels prevented the Bureau of Planning from renewing its Coastal Zone Management grant to DAWR.

The Division has focused much of its efforts on programs and activities geared towards the development, understanding and appreciation of Guam's fish and wildlife resources. Its PACE program, thus far, consists primarily of class presentations, public service announcements, press conferences and releases, public displays, periodical newspaper columns and feature articles, information pamphlets, coloring books and activity guides for elementary school children.

The effectiveness of these programs and activities can best be measured by the community's continuing response in reporting poaching activities to conservation officers and police, the increase in teacher requests for fish and wildlife presentations, the willingness of the business sector to assist in the education of potential violators, and the number of individuals who have volunteered to help in our mission. As in the past, residents continue to respond to calls for snake specimens, report forest bird sightings, bring in injured birds or birds presumed to be endangered species, and generally to encourage the institution of more intensive management programs for Guam's fish and wildlife resources.

PROCEDURES AND RESULTS

To date, activities and efforts include:

1. Implementation of DAWR's first-ever Kids' Marine Fishing Derby held December 1 and 2, 1990. The Derby, co-sponsored by the Department of Youth Affairs, which solicited prizes, saw the participation of 34 kids ages seven through 10, compete in two separate days of competition. Prizes included trophies for first place finishers in the Heaviest, Most and Longest Fish categories, and fishing tackle for second and third place finishers. All participants were awarded Certificates of Participation as well as food coupons from Burger King.
2. Implementation of the first-ever Fena Lake Freshwater Fishing Derby for Kids held May 4th and 5th, 1991. The derby was a cooperative effort between the DAWR and the U. S. Naval Magazine Command. Eighty-six kids between seven and 12 participated in the first-ever public freshwater fishing derby. Prizes similar to the marine fishing derby were given.
3. Translation of Guam's Fishing Laws and Regulations from English to Korean. The translation will result in the publication of a multi-lingual information pamphlet for distribution not only to shipping lines, tuna fishing boats, construction companies, tourists and airlines, but also the community in general. The publication of such a pamphlet is a vital part of DAWR's conservation education program due for the most part, to the lack of knowledge and understanding of Guam's fish and wildlife management programs by the island's increasing foreign visitors.
4. Purchase of professional display boards to replace dilapidated makeshift boards.
5. Continued airing of Public Service Announcements on fish and wildlife conservation on public and network television stations as well as spots on media wall units in shopping malls.

6. Exhibition of DAWR displays on Brown Tree Snakes and the impact of poaching on Guam's endangered species and fish and wildlife resources. Both displays were exhibited during Earth Week observance at the Micronesia Mall, the anniversary celebration of the War in the Pacific National Historical Park, the Micronesian Cultural Fair at Ipao Beach Park and the University of Guam Charter Day festivities. An estimated 10,000 to 15,000 schoolchildren and adults have viewed this display.
7. Continuation of school visits by the PIO and COs. Nearly 2,300 (2,292) students or 87 classes were visited this year, a slight increase over the previous year. The total number of visits does not accurately reflect the number of teacher requests received since many could not be fulfilled due to other priorities. The wildlife presentation consists of a slide show on endangered species and game management, while the fish presentation consists of a 25-minute video tape on coral reef ecology and an overview by COs of Guam's fishing laws and regulations. Presentations are complemented by a display of live and preserved animals, followed by a question-and-answer period.
8. Participation in the following workshops, meetings, and activities:
 - a) Guam and Commonwealth of the Northern Marianas Wildlife Staff Workshop held in Rota, CNMI in November, 1990
 - b) Aquatic Resource Education Conference held in July 1991 at Port Angeles, Washington;
 - c) Beginning and Intermediate Class on Desktop Publishing in February, 1991
 - d) Senior Leadership Day, September 1991
 - e) Dededo Middle School Science Fair Competition
 - f) Multi-Media seminar in April 1991
9. Developing press releases and arranging press conferences focusing on DAWR's programs and activities;
10. Duties as assigned by the Division Chief and Assistant Chief.

RECOMMENDATIONS

1. Immediately fill the locally-funded position of Assistant Public Information Officer, created during this fiscal year, to assist the PIO in the implementation of current programs and the development of contemporary programs in pursuit of its goal to inform and educate Guam's multi-ethnic and culturally-diverse population.
2. Continue both freshwater and marine derbies for kids and initiate an adult freshwater fishing derby.
3. Immediately implement the planned Aquatic Education Leadership Workshop for public and private school teachers.
4. Continue fish and wildlife presentations at schools and libraries, both public and private, and other organizations.
5. Immediately publish Guam's fish and wildlife laws and regulations in multi-lingual form to better educate and inform Guam's non-English speaking community.
6. Continue public awareness program through press releases, news articles, press conferences and other media to keep the public informed of the progress and accomplishments of the Division's fish, wildlife and endangered species programs. The program should continue to target not only Guam's local students and residents but also H-2 workers, tourists and other transients, many of whom are the chief violators of Guam's fish and wildlife laws.
7. Construct and erect international beach signs at major beaches throughout Guam and other sites frequently victimized by coral and fishing violators.

8. Develop a 30-minute educational video documentary on DAWR's programs and activities for public broadcast and dissemination to all public and private education institutions.
9. Secure funding for printing of fish and wildlife conservation bumper stickers and flyers, posters on the Marianas Fruit Bat, Brown Tree Snakes and development of other materials.
10. Encourage and support the creation of and actively participate in the activities of an education/information network comprised of educators and resource persons from environmentally-related departments and agencies. The nationally-renown Project Learning Tree (PLT), which made its debut on Guam in August 1990, has been well-received and continues to make headway in elementary, middle and high schools but on the university level as well. A national program of the American Forestry Council and funded by the U.S. Forest Service, the American Association of State Foresters, and other benefactors, the PLT is currently being administered on Guam by the local Department of Education, the University of Guam, and the Forestry Division of the local Department of Agriculture. The DAWR PIO was among the participants in the first Guam PLT leadership workshop however, due to division priorities, the role has been more as a resource person than a workshop facilitator.
11. Coordinate the Division's participation in mutual programs and projects with Guam's Department of Education, Coastal Zone Management, Sea Grant, the University of Guam Extension Service, Department of Parks and Recreation, and the Environmental Protection Agency.

Report prepared by: Lillian L. Mariano

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: F-1

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1990 to September 30, 1991.

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin and other boat launching locations along Guam's shoreline from October 1990 through September 1991. An island-wide finfish catch from small recreational-type vessels is estimated at 422.4 metric tons (m.t.) for that period. The bulk of the catch, 363.1 m.t., was landed by trolling during an estimated 56,887 boat-hours of effort. The bulk of the troll catch, 348.8 (354.7 GOES) m.t., consisted of five major pelagic species. Bottomfishing produced an estimated 21.8 m.t., primarily snappers and emperors, and night-light jigging for atulai produced an estimated 10.2 m.t. Spearfishing produced 16.6 m.t. of finfishes and 1.8 m.t. of shellfish. Approximately 8.9 m.t. of finfish and 0.1 m.t. shellfish were caught by spincasting, hand or gill net. Catches by infrequently encountered methods may be under-estimated as follows: bottomfishing (1.6 %); spearfishing (8.0 %); nightlight jigging for atulai (2.5 %); and all other methods combined (10.8 %).

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods used and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past 14 years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. Recently, however, major advances have been made in both field survey techniques and in the area of computerized statistical analysis. Much of this progress has resulted from the combined efforts of DAWR and National Marine Fisheries Service (NMFS) personnel through the Western Pacific Fisheries Information Network (WPACFIN) program (see Study F-1, Job 3).

OBJECTIVES

1. To quantify fishing participation, effort, and catch which occurs outside the reef margin in boats.
2. To collect biological data from the specimens examined during interviews.

PROCEDURES

During FY91, interviews of returning offshore fishing parties were conducted on four days each month at the Agana Boat Basin. Two of these days were randomly selected weekdays

and two were randomly selected weekend days (which, in this report, includes holidays). Each survey consisted of two periods, one from 0500 to 1200 hours (previously to only 1100 hours) and the other from 1600 to 2400 hours. In addition, interviews from the southern launching site of Merizo Pier were obtained on one day per month, alternating between weekdays and weekends from the hours of 0600 to 1100 and 1600 to 2000. Island-wide participation was determined by means of a morning and evening survey of all public boat launching areas in which all trailers attached to vehicles were counted, but no interviews were taken. This assumes that the proportion of boat trips participating in fishing to boat trips not participating in fishing as well as the proportion of boats engaging in each method for boats utilizing the Agana Boat Basin is representative of the island as a whole.

Sampling and analytical procedures used in the GOES (Guam Offshore Expansion System) remain basically unchanged from those outlined in the FY85 annual report, with the following exceptions:

1. The changes implemented in response to observations of fishing activity during the three-day Guam International Fishing Derby (GIFD) remain the same as those outlined in the FY88 annual report. In addition, a three-day Z-Best Derby in September attracted even more boats than the GIFD. However a large number of non-derby participants also fished during the three days, so it was determined that adding results of the derby to the 30-day expansion would sufficiently address the problem. Therefore the statistics for the month of July and for the year for trolling and bottomfishing are based on 28-day and 362-day expansions, respectively, with the GIFD and Z-Best Derby results added for trolling. Statistics for the remaining methods are based on 31-day and 365-day expansions for July and the year, respectively*. Other one and two-day derbies with relatively low turnouts were not considered separately from the normal expansion.
2. The method used to assess the degree of under-sampling reflected in the GOES output for the FY85-88 annual reports assumes that there are no differences between WD and WE/H days, and in the case of spearfishing, assumes that there is no difference between scuba and snorkeling methods. Therefore, this method was modified to consider each of these potential differences separately by multiplying the average daily parameters of catch and effort separately for each method and day type by the correction factor, F where:

$$F = \frac{n(P_o)}{P_i P_o}$$

= no. of days (WD or WE/H)
= the sum of boats known to participate in a given method for all days censused
P_i = the sum of boats known to participate in a given method for days in which an interview was obtained

RESULTS

Trolling

An estimated 363.1 m.t. of troll-caught fish were landed island-wide during FY91 (Table 1). Monthly catches ranged from a high of 72.8 m.t. in March to a low of 10.5 m.t. in October (Figure 1). An estimated 56,887 boat-hours were spent trolling with an average

* Refer to Appendices I and II for detailed reports on the GIFD and Z-Best Derby results.

catch rate of 6.4 kg/boat-hour. Monthly catch rates as catch per unit of effort (CPUE), ranged from 2.8 kg/boat-hour in October to 14.5 kg/boat-hour in March.

The usual five pelagic species accounted for the bulk of the catch (97.6%; Table 2). Mahimahi (*Coryphaena hippurus*; 50.3%) was the most important species, followed by blue marlin (*Makaira nigricans*; 17.1%), skipjack tuna (*Katsuwonus pelamis*, 15.5%), wahoo (*Acanthocybium solandri*; 8.0%), and yellowfin tuna (*Thunnus albacares*; 6.7%). Scombrids collectively comprised only 30.9% of the total trolling catch.

The estimated troll fisheries catch for FY91 was the largest on record, exceeding that of the previous record catch of 342 m.t. in FY88. The estimated FY91 trolling catch was 34% higher than the 270 m.t. landed in FY90 and 79% higher than the 203 m.t. landed in FY89. However, it should be noted that statistically, at the 90% confidence level, the FY91 catch was not significantly different from either the FY88 or FY 90 catches although it was significantly higher than the FY89 catch.

The record catch of FY91 was due entirely to a record mahimahi catch of 180 m.t., which comprised over 50% of the total catch. Thirty-four percent of the mahimahi were caught in March. The FY91 blue marlin catch of 61.3 m.t., also a record catch, was only slightly higher than the previous years catch. The FY91 catch of wahoo was 52% lower than the record catch of FY90 and the lowest in seven years. The FY91 catches of skipjack tuna and yellowfin tuna were 17% and 14% lower than those of FY90, respectively, but were higher than the FY89 catches. Since it is not yet possible to calculate confidence intervals for catches of a given species, it is unknown, which of these differences is significant. It should be noted that the yellowfin tuna catch consisted primarily of small immature fish. However, a few large tuna (> 45 kg) were caught, particularly during the GIFD. Catches of each of the usual five minor species (rainbow runner, great barracuda, kawakawa, dogtooth tuna, and sailfish) remained low, below 1.3 m.t. More sharks than usual were retained by the fishermen, with an estimated 3.2 m.t. landed, primarily silky sharks. Also notable was the appearance of juvenile striped marlin (*Tetrapterus audax*), ranging in weight from 4 to 11 kg, in November.

FADs had little impact during FY91 primarily because most went off site or became submerged early in the year. Three of the four FADs present at the beginning of FY91 were apparently lost or submerged during the passage of Typhoon Russ. The remaining FAD, approximately 3 miles off Haputo Point became partially submerged in April and totally submerged by May. It has not been located since. The surveys produced no useable information on FAD related catches during FY91.

The large catch of FY91 can be explained almost entirely by the high catch rate for mahimahi (peaking at 12.2 kg/boat hour in March). The overall catch rate of 6.2 kg/boat hour exceeded that of the previous record catch year of FY88 (6.0 kg/boat-hour). The FY91 estimates of participation in terms of person-trips and boat trips, set new records of 60,848 and 13,074, respectively. However, the latter figure was only slightly higher than that of FY90. The FY91 estimate of effort as person-hours also set a new record (255,822), but the estimate of effort as boat-hours (56,887) was lower than the FY90 and FY88 estimates (60,489 and 57,365 respectively). These figures are consistent with the charter boat segment of the troll fishery continuing its rapid growth, outpacing that of the non-charter segment. Charter vessels generally carry more people but spend less time fishing per trip than non-charter vessels. Their larger size enables them to go out more often during marginal weather conditions and they target marlin more frequently than non-charter vessels.

Bottomfishing

An estimated 21.8 m.t. of bottomfishes were landed island-wide during FY91 (Table 3). Estimated monthly catches ranged from a high of 7.7 m.t. in August to a low of 0.2 m.t. in November. Bottomfish landings fluctuated widely, with generally poorer catches from November to May. An estimated 24,993 person-hours were spent during 8,076 boat-hours of bottomfishing, resulting in an overall catch rate of 2.7 kg/boat-hour. Monthly catch rates ranged from 1.2 kg/boat-hour in February and May to 4.4 kg/boat-hour in August.

The estimated bottomfishing catch for FY91 was 7.8% higher than that of FY90, but all measures of participation and effort ranged from 1.3 to 10.8% less. However, none of the FY91 estimates are significantly different at the 90% level from those of FY90 or FY89.

The composition of FY91 bottomfish catch was also similar to that of recent years, with snappers (Lutjanidae) and emperors (Lethrinidae) accounting for 44% and 28% of the weight landed, respectively (Table 4). The most important snappers were the deepwater yellowtail kalikali (*Pristipomoides auricilla*, 1.8 m.t.), lehi (*Aphareus rutilans*, 1.4 m.t.), opakapaka (*P. filamentosus*, 1.1 m.t.), ehu (*E. carbunculus*, 1.1 m.t.), and gindai (*P. zonatus*, 1.0 m.t.), followed by the uku (*Aprion virescens*, 0.8 m.t.), a shallow species that ranges into deeper water, the deepwater yellow-eye opakapaka (*P. flavipinnis*, 0.6 m.t.), and the primarily shallow water ta'a'pe (*Lutjanus kasmira*, 0.6 m.t.). The emperor catch consisted primarily of the redgilled emperor (*Lethrinus rubrioperculatus*, 4.1 m.t.) which remained the single most important bottomfish species, comprising 19% of the overall bottomfishing catch and 67% of the emperor catch. As in most recent years, groupers (Serranidae, 2.5 m.t.) ranked third in importance (12%) with three species (*Epinephelus fasciatus*, 1.0 m.t.; *Cephalopholis sonnerati*, 0.4 m.t.; and *Variola louti*, 0.3 m.t.) predominating. Other important families included the jacks (Carangidae, 5%), requiem sharks (Carcharhinidae, 3%), goatfishes (Mullidae, 2%), wrasses (Labridae, 2%), and barracudas (Sphyraenidae, 1%).

Relatively shallow water species (found primarily at depths of 150 m or less) comprised nearly twice as much of the catch (14.3 m.t. or 66%) as did deeper water species (found primarily below 150 m; 7.4 m.t. or 34%). However, the shallow dwelling segment of the bottomfish catch consisted of many more species than did the deepwater segment so that six of the top ten species were from deepwater. The continued importance of small species with high turnover rates at shallow to moderate depths (e.g. *Lethrinus rubrioperculatus* and *Epinephelus fasciatus*), is indicative of a heavily-fished resource. However, relatively steady CPUEs indicate that the fishery is stable at current levels of participation. Unchecked increases in participation could result in significantly lower CPUEs and catches in the future. Since the GOES does not distinguish between shallow and deep effort, it is not yet possible to calculate separate statistics for participation or effort for shallow and deepwater bottomfish fisheries. Based on days in which this method occurred but no interviews were obtained, it is believed that the GOES underestimated the participation, effort, and catch of this method by 1.6%.

Spearfishing

The estimated monthly and annual participation, effort, and catch for spearfishing from boats during FY91 is summarized in Tables 5 and 6. (Readers should also refer to Study F-1, Job 2 for estimates of spearing from shore, i.e., without the use of boats, to gain a more complete picture of FY91 spearfishing activities on Guam.)

An estimated 18.4 m.t. of speared fish, crustaceans, and mollusks were landed from boats during FY91, more than double the catch of FY90 and 55% higher than the historic high catch of 11.9 m.t. in FY88.

More than twice as much of the catch was taken by scuba diving than by snorkeling (12.2 vs. 5.4 m.t. with 0.8 m.t. undetermined) but nearly twice as much effort was by snorkeling (1,650 vs. 883 boat hours with 37 boat hours undetermined). Effort as boat hours for spearfishing by scuba diving as well as snorkeling remained within the ranges reported for recent years. The overall catch rate for spearfishing in FY91 was 10.2 kg/boat hour with the catch rate by scuba diving nearly five times that by snorkeling (21.6 vs 4.5 kg/boat hour). The catch rate for spearfishing using scuba during FY91 was approximately triple that of recent years, while that for snorkeling remained similar.

Factors that contributed to the exceptionally large spearfishing catch by scuba diving included considerable effort in deep water (> 30 m), a relatively high interception rate (the underestimate of GOES expansion for FY91 of 8% vs. $\geq 20\%$ in recent years), and good weather. However, few of the differences between the annual estimates are significant at even the 90% level of confidence. It may not be possible to detect statistically significant differences between years, even if they do exist, at the current level of sampling since spearfishing is an uncommonly encountered method. The fact that a large number of scuba-diving spearfishermen are now concentrating their efforts in deep water is an indication of poor fishing in shallow water. Since some spearfishing parties return late at night outside our survey period and the GOES only considers complete interviews, we believe that all recent annual estimates are low. Based on days in which participation in spearfishing occurred, but interviews were not obtained, it is believed that the GOES expansion for FY91 underestimates the spearfishing participation, effort, and catch by 8.0%.

As in previous years, parrotfishes (Scaridae; 46%), surgeonfishes (Acanthuridae; 22%), and wrasses (Labridae; 8%) dominated the FY91 spearfishing finfish catch (Table 7). Groupers (Serranidae; 7%) were fourth in importance, followed by snappers (Lutjanidae; 5%), emperors (Lethrinidae; 2%), rudderfishes (Kyphosidae; 2%), goatfishes (Mullidae; 2%), sweetlips (Haemulidae; 4%), and rabbitfishes (Siganidae; 1%). Other families each comprising less than 1% of the finfish catch included squirrelfishes (Holocentridae), mullets (Mugilidae), filefishes (Monacanthidae), jacks (Carangidae), barracudas (Sphyraenidae), puffers (Tetraodontidae), spadefishes (Ephippidae), triggerfishes (Balistidae), fusiliers (Caesionidae), bigeyes (Priacanthidae), hawkfishes (Cirrhitidae), sweepers (Pempheididae), and butterflyfishes (Chaetodontidae).

In addition to fishes, an estimated 1.8 m.t. (10% of the catch) of mollusks (primarily the aliling, *Trochus niloticus*) and crustaceans (primarily spiny lobsters, mainly *Panulirus penicillatus*) were harvested by spearfishing parties during FY91.

Atulai Night-Light Jigging

Atulai (*Selar crumenophthalmus*) fishing was encountered during the months of October, May, July, August, and September.

An estimated 10.2 m.t. of fishes were landed by night-light jigging during 2,189 boat-hours of effort during FY91. Most of this consisted of atulai (*Selar crumenophthalmus*; 9.6 m.t., 94%) and the remaining incidental catch consisted of jacks (other species of Carangidae; 0.3 m.t., 3%), and negligible quantities of snappers (Lutjanidae), emperors (Lethrinidae), barracudas (Sphyraenidae), and squirrelfishes (Holocentridae). It is estimated that the GOES underestimated the participation, effort, and catch of this method by 2.5%.

The estimated FY91 catch of atulai was midway between the low catches of FY87, 88, and 90, but considerably less than the high catches of FY85 and 89. Participation and effort was also midway between the recent high and low catch years. Some of these differences in catches and effort are significant at the 90% level, indicating that it is unlikely that they could have resulted entirely by chance due to the low frequency of sampling. Several factors may contribute to the large variation in annual estimates for the atulai fishery. These include a shift in participation from the Agana Boat Basin to other landing sites, annual differences in weather on the best nights for the fishery, and shifts in interest due to the condition of other fisheries as well as socio-economic factors. A comparison of the moon phases of survey days between years would be useful for determining if the observed differences are due primarily to sample design.

Other Methods

Other rarely encountered methods during FY91 included gill netting, spincasting from an anchored boat, and by hand (the latter method may utilize a knife or hand tool or no equipment at all). Together, they produced an estimated catch of 9.0 m.t. (8.8 m.t. of finfishes and 0.2 m.t. of shellfish, mostly aliling (topshell, *Trochus niloticus*) during 1,522 boat-hours and 4,379 person-hours of effort spent on 454 boat trips. It is believed that the GOES underestimated the combined participation, effort, and catch for these methods by about 10.8%.

Overview

Including major derbies, an estimated 422.4 m.t. (90% confidence limit [CL] $\leq$ 104.0 m.t.) of finfish (420.6 m.t.) and shellfish (1.8 m.t.) were landed island-wide by boats utilizing a variety of methods beyond the reef margin during FY91. An estimated 17,415 boat trips (CL $\leq$ 2,569) were made in which 295,904 person-hours (CL $\leq$ 38,486.4) were spent during 70,470 boat-hours of fishing (CL $\leq$ 10,418). Excluding days with major derbies, the average daily participation is estimated at 31.4 boat trips per weekday and 69.7 boat trips per weekend day or holiday, both all-time highs and 20 % and 4 % higher than the previous years respective participation figures.

Excluding fishing derbies, overall monthly catch rates (kg/boat-hour) ranged from 3.9 kg/boat-hour in October to 14.1 kg/boat-hour in March with an annual average of 6.1 kg/boat-hour, (46% higher than that of FY90 and 22% higher than the previous highest catch year of FY88). Including the GIFD and Z-Best derbies, trolling accounted for 86.0% of the FY91 catch (363.1 m.t., 90% CL = 69.1 m.t.), bottomfishing comprised 5.2% of the catch (21.8 m.t.; 90% CL = 8.6 m.t.), spearfishing accounted for 4.4% (18.4 m.t.; 90% CL = 10.5 m.t.) of the catch, night-light jigging for atulai, accounted for 2.4% of the catch (10.2 m.t.; 90% CL = 7.6 m.t.), and other rare methods, accounted for 2.1% (8.2 m.t.) of the catch.

The estimated trolling catch reached an all-time high, some 6.3% higher than the previous all time high of FY88. Catch per unit of effort (CPUE) was slightly higher than that of FY88, but about 30% higher than last years. The increased catch was due primarily to record catches of mahimahi and blue marlin. Some of this was due to increased charter fishing activity, which targets marlin.

The FY91 bottomfishing catch remained essentially unchanged from that of the past three years. CPUEs for bottomfishing have remained steady for the past five years, while participation doubled between FY87 and 88. Although relatively steady CPUEs indicate that these fisheries are stable at current levels of participation, unchecked increases in participation could result in significantly lower CPUEs and catches in the future. There is

little doubt that the high levels of boating and fishing activity of the last four years is the result of Guam's current economic boom and rapid development and that these levels will likely remain high or increase in the foreseeable future.

Participation, catch, and effort for spearfishing using scuba may have increased considerably over that of recent years. This is probably a result of a shift in effort to deeper waters and is an indication of poor catches in shallow water.

Participation, catch, and effort for night-light jigging for atulai have fluctuated greatly during the last few years, with the estimates for FY91 falling approximately midway between high and low catch years.

RECOMMENDATIONS

There is little doubt that the reliability of estimates of island-wide catch and effort based on the present survey is limited by the quality of participation data taken at sites other than the Agana Boat Basin under the assumption that activity as well as catches landed there are representative of the island as a whole. However, data collected at Merizo Pier during FY89-'91 indicates that this is not the case, but that there is proportionately much less trolling activity and much more bottomfishing, spearfishing, and gillnet activity occurring there. We still do not have a clear idea how much boating participation takes place from less accessible landings (e.g. the private Achang Bay Marina), nor do we know the proportionality of the various methods at these areas or at the Agat Marina. Island-wide estimates for the past several years are therefore disproportionately high for trolling, but low for other methods. Since these other methods are the only ones that are locally manageable, it is imperative that the survey results are unbiased as well as based on an adequate sample of interviews from launch sites other than the Agana Boat Basin. Separate expansions for the Agana Boat Basin and other boat launching sites would be desirable. It will also be necessary to reassess annual island-wide estimates of catch and effort as far back as possible.

Since all major trolling species have broadly distributed stocks, some of which are believed to be Pacific-wide, meaningful management and conservation of these resources will only be possible by international regional cooperation. This will require that databases be made available from as many sources and areas as possible, and that any biological assessment be based on adequate region-wide data. There are presently few areas from which adequate data on recreational or subsistence fisheries are available, significant gaps in the data for both foreign and domestic distant-water fisheries, and virtually no information on the interaction of recreational and large-scale commercial fisheries. It is therefore essential that the current time-series of data from Guam be maintained. Since Guam's recreational troll fishery is incapable of taking more than a fraction of a percent of these stocks and could not have an adverse affect on them, and since the activities of both domestic and foreign large-scale commercial fisheries can significantly affect the performance of Guam's recreational fishery, it is imperative that Guam's recreational fisheries interests be represented and protected in any regional forum.

In order to effectively manage those fisheries that are specific to Guam, or to Guam and nearby islands and banks, additional biological information is needed on major bottom- and spearfished species. The offshore survey is currently too infrequent to obtain sufficient data to perform certain length-based analyses of any of these species. It is recommended that separate studies of the major bottomfish species be implemented that examine reproduction and ecology as well as length-frequency distributions. Comparisons with the inshore survey will have to be made to determine which spearfished species require further study.

In order to address the problems described above, the following projects have been implemented or proposed:

1. The GOES program will be rewritten and modified for use on the data base software "4th Dimension" on the Fishery Section's Macintosh SE/30 computer system. Dr. Steven Amesbury of the University of Guam Marine Laboratory is currently under contract to prepare the new GOES program. Modifications expected in the GOES will: (1) enable the program to produce more accurate expansions that factor in days in which a given method occurred but no interviews were obtained; (2) produce separate estimates for shallow- and deepwater bottomfisheries; and (3) use additional location codes to more accurately distinguish between trips that include or exclude offshore banks. The software and hardware itself will greatly reduce the time needed to produce expansions as well as greatly reduce risks of input or transcription errors by making it possible to save subsets and files without having to re-enter variables, and by eliminating the need for dumping compiled summary data on other software in order to produce tables and charts. This will make it possible to quickly and efficiently examine many aspects of the data base that are impractical to exam under the current system as well as make it possible to re-expand the historic data base using more accurate information on participation.
2. A separate, intensive study of island-wide participation in small-boat fisheries on a method and area-specific basis in order to produce more accurate island-wide expansions should be conducted.
3. Studies of the major bottomfish species *Epinephelus fasciatus*, *Variola louti*, and *Lethrinus rubrioperculatus* that examine reproduction and ecology as well as length-frequency distributions to be initiated under the D-J funded project "Studies of Recreationally Important Reef Fish" (project no. FW-2R Job F-1).
4. An increase in staffing to adequately cover the Agat Marina and other launch sites while maintaining the current level of coverage at the Agana Boat Basin.

Therefore, we recommend that this job be continued, that sampling techniques continue to be refined or expanded as necessary, and that historic annual estimates of catch and effort be reassessed. We also recommend that staff fisheries biologists continue to work closely with NMFS personnel in improving the efficiency and accuracy of our computerized data analysis techniques, and that they take an active roll in regional management activities through the Council and other regional organizations.

Report prepared by Robert F. Myers

Table 1. Estimated monthly and annual trolling participation, effort, and catch during FY '91. Estimates include major derbies. Weights are in kilograms (1 kg = 2.2046 lbs).

A) PARTICIPATION:						
MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	4,869.3	908.3	2,137.2	1,010.4	74.3	174.7
NOV	5,388.3	581.1	1,367.2	1,034.7	160.6	377.8
DEC	3,912.9	396.9	934.0	872.5	133.5	314.2
JAN	6,119.7	890.3	2,094.9	1,202.5	116.7	274.5
FEB	3,741.4	1,014.2	2,386.4	962.1	260.7	613.4
MAR	4,956.7	227.5	535.4	1,132.5	174.4	410.3
APR	4,722.2	455.2	1,071.1	933.6	20.7	48.7
MAY	4,698.5	1,102.6	2,594.5	1,051.9	274.3	645.4
JUN	5,581.8	391.4	921.0	1,285.8	136.0	320.1
JUL*	4,757.6	472.0	1,110.7	1,208.1	18.5	43.6
AUG	3,301.4	1,401.0	3,296.6	895.2	375.5	883.7
SEP**	8,388.4	779.5	1,834.1	1,553.9	86.8	204.3
TOTAL	60,438.2			13,143.2		
GOES	60,848.1	3,158.6	5,319.0	13,269.4	634.5	1,068.4
B) EFFORT:						
MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	17,674.4	3,515.9	8,272.8	3,681.9	304.1	715.5
NOV	22,081.8	4,422.0	10,405.1	4,286.0	1,033.9	2,432.8
DEC	17,443.5	2,176.2	5,120.5	3,820.7	455.2	1,071.1
JAN	23,873.4	1,214.7	2,858.2	4,759.2	60.8	143.2
FEB	16,587.9	5,224.8	12,294.0	4,304.3	1,418.7	3,338.3
MAR	20,814.9	1,828.0	4,301.3	5,028.7	1,366.4	3,215.2
APR	19,487.4	2,636.1	6,202.7	3,841.2	240.1	565.0
MAY	19,290.6	4,800.9	11,296.5	4,331.4	1,201.0	2,826.0
JUN	24,643.6	3,270.0	7,694.3	5,718.9	965.1	2,270.9
JUL*	24,922.7	966.9	2,275.1	6,755.3	283.0	666.0
AUG	11,154.3	4,017.5	9,453.1	3,106.5	1,034.3	2,433.6
SEP**	35,044.7	3,354.5	7,893.0	6,473.2	390.0	917.7
TOTAL	253,019.2			56,107.3		
GOES	255,821.9	13,837.2	23,301.8	56,886.7	3,085.5	5,196.1
C) CATCH:						
MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	10,481.7	1,192.6	2,806.1	10.4	2.8	0.6
NOV	16,673.3	3,650.7	8,590.2	16.1	3.9	0.8
DEC	16,539.7	5,287.1	12,440.6	19.0	4.3	0.9
JAN	36,732.3	4,999.0	11,762.7	30.5	7.7	1.5
FEB	40,533.2	14,719.3	34,634.4	42.1	9.4	2.4
MAR	72,776.6	25,405.3	59,778.6	64.3	14.5	3.5
APR	30,608.4	586.1	1,379.2	32.8	8.0	1.6
MAY	28,666.6	11,368.8	26,750.8	27.3	6.6	1.5
JUN	23,374.8	7,100.4	16,707.2	18.2	4.1	0.9
JUL*	25,722.8	2,472.5	5,817.9	21.3	3.8	1.0
AUG	17,187.1	3,847.1	9,052.1	19.2	5.5	1.5
SEP**	38,441.2	7,926.8	18,651.7	24.7	5.9	1.1
TOTAL	357,737.7			27.2	6.4	1.4
GOES	363,082.3	41,022.6	69,082.0	27.4	6.4	1.4

* Based on participation, effort, and catch totals for the GIFD added to the GOES 28 day expansion.

** Based on the GOES 30 day expansion with the participation, effort, and catch totals for the 3 day Z-Best derby added.

Table 2. Monthly and annual composition of the Guam trolling catch during FY '91. Estimated weights are in kilograms and include the GIFD.
A + indicates less than 0.05% of the annual catch.

Family and Species	Oct	Nov	Dec	Jan '90	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	total	% of total
<i>Carcharhinidae</i>														
<i>Carcharhinus amblyrhynchos</i>									515.6				515.6	0.1
<i>Carcharhinus falciformis</i>						1746.1		903.5		24.3			1770.4	0.5
<i>Carcharhinus galapagensis</i>													903.5	0.3
<i>Carangidae</i>														
<i>Caranx melampygus</i>		30.4	17.2	60.8				27.1	125.0	7.9			35.0	+
<i>Elegans bipinnulatus</i>								61.0		308.5	99.2		702.1	0.2
<i>Coryphaenidae</i>														
<i>Coryphaena hippurus</i>	2,922.1	5,807.0	8,215.9	29,134.5	32,676.6	61,229.3	25,771.2	11,707.0	1,127.2	222.7	274.9	882.3	179,970.7	50.3
<i>Lutjanidae</i>														
<i>Aphareus furca</i>								4.9		52.4			57.3	+
<i>Spyraenidae</i>														
<i>Sphyræna barracuda</i>	23.4	108.0	73.5		58.0				135.3	98.2	57.6		554.0	0.2
<i>Scombridae</i>														
<i>Acanthocybium solandri</i>	1,570.9	5,997.4	2,966.9	4,294.9	2,104.2	2,547.4	1,224.0	1,119.5	2,786.8	879.1	538.0	2,432.4	28,461.5	8.0
<i>Euthynnus affinis</i>	14.1	105.0	267.8	119.2		61.8		34.2	23.2	75.1	219.9	327.0	1,247.3	0.3
<i>Gymnosarda unicolor</i>	85.9		98.1	562.1	297.7	123.6			119.9	15.7			1,303.0	0.4
<i>Katsuwonus pelamis</i>	2,625.9	2,961.6	2,733.7	786.6	2,739.4	2,473.6	2,303.6	9,019.9	8,266.2	7,152.3	3,564.6	10,662.7	55,290.1	15.5
<i>Thunnus albacares</i>	3,239.4	427.4	2,166.7	1,409.1	2,329.2	2,623.0	270.9	1,770.3	3,201.8	4,017.9	1,700.7	636.2	23,792.6	6.7
unid. tuna							42.2						42.2	+
<i>Istiophoridae</i>														
<i>Istiophorus platypterus</i>				365.0			460.0						825.0	0.2
<i>Makaira nigricans</i>		1,064.7				1,477.5	536.6	4,019.1	7,073.9	12,869.1	10,732.2	23,500.5	61,273.6	17.1
<i>Tetrapterus angustirostris</i>					328.0	494.3							822.3	0.2
<i>Tetrapterus audax</i>		171.9											171.9	+
Total	10,481.7	16,673.3	16,539.7	36,732.3	40,533.2	72,776.6	30,608.4	28,666.6	23,374.8	25,722.8	17,187.1	38,441.2	357,737.7	100.0

Table 3. Estimated monthly and annual Guam bottomfishing participation, effort, and catch during FY '91.

A) PARTICIPATION:						
MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	596.5	174.3	410.1	241.8	77.1	181.5
NOV	122.2	110.6	260.1	34.9	31.6	74.3
DEC	321.6	88.4	207.9	103.3	43.5	102.4
JAN	87.2	78.9	185.7	43.6	39.5	92.8
FEB	208.6	21.6	50.9	84.9	6.3	14.9
MAR	207.5	141.9	334.0	71.7	49.7	117.0
APR	149.2	19.2	45.3	60.3	2.7	6.5
MAY	879.6	188.2	442.8	230.8	73.7	173.4
JUN	730.5	223.9	526.9	222.6	49.0	115.3
JUL*	973.8	73.5	173.0	350.8	18.7	44.1
AUG	1,274.9	661.7	1,556.9	413.2	177.8	418.4
SEP	729.8	74.6	175.5	244.7	26.8	63.1
TOTAL	6,281.4			2,102.6		
GOES**	6,473.7	919.7	1,548.7	2,162.2	279.6	470.8
B) EFFORT:						
MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	2,503.5	446.9	1,051.6	993.9	203.7	479.4
NOV	198.6	179.7	422.7	56.7	51.3	120.8
DEC	884.1	507.1	1,193.1	329.8	218.7	514.5
JAN	159.9	144.7	340.4	80.0	72.3	170.2
FEB	501.2	243.2	572.3	185.9	64.5	151.8
MAR	603.8	454.4	1,069.1	169.2	111.2	261.5
APR	516.3	20.3	47.7	217.1	45.7	107.5
MAY	2,888.8	387.9	912.8	752.4	236.5	556.4
JUN	3,042.1	939.4	2,210.4	938.1	207.4	488.0
JUL*	3,851.2	472.0	1,110.6	1,471.9	372.6	876.7
AUG	5,398.6	3,182.7	7,489.0	1,736.9	976.0	2,296.5
SEP	2,679.0	530.6	1,248.4	910.7	219.5	516.6
TOTAL	23,227.1			7,842.6		
GOES**	23,992.7	4,010.4	6,753.5	8,076.0	1,313.1	2,211.3
C) CATCH:						
MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	2,828.8	761.5	1,791.8	11.7	2.8	1.1
NOV	183.9	166.3	391.3	5.3	3.2	0.9
DEC	905.5	745.4	1,753.8	8.8	2.7	1.0
JAN	170.1	153.9	362.0	3.9	2.1	1.1
FEB	213.8	33.4	78.7	2.5	1.2	0.4
MAR	549.0	404.1	950.8	7.7	3.2	0.9
APR	417.3	121.9	286.8	6.9	1.9	0.8
MAY	868.7	275.7	648.7	3.8	1.2	0.3
JUN	2,410.9	485.5	1,142.3	10.8	2.6	0.8
JUL*	3,771.1	593.3	1,396.0	10.8	2.6	1.0
AUG	7,704.9	4,780.4	11,248.3	18.6	4.4	1.4
SEP	1,355.0	217.0	510.7	5.5	1.5	0.5
TOTAL	21,379.0			10.2	2.7	0.9
GOES**	21,775.6	5,124.4	8,629.5	10.1	2.7	0.9

* Results are based on a 28 day expansion on the assumption that bottomfishing was negligible during the three day GIFD.

** Results are based on a 362 day expansion based on the assumption that bottomfishing was negligible during the three day GIFD.

Table 4. Composition of the Guam bottomfishing catch during FY '91. Estimated weights are in kilograms. Percentages are based on the differentiated portion of the catch only. The data is based on a 362 day expansion which assumes that bottomfishing activity was negligible during the three day GIFD.

FAMILY	Shallow Species Weight	%	Deep Species Weight	%	Total Weight	%
Carcharhinidae (Requiem sharks)	701.3	5.1			701.3	3.3
Muraenesocidae (Pike eels)			6.4	0.1	6.4	0.0
Polymixidae (Beardfishes)			12.8	0.2	12.8	0.1
Belonidae (Needlefishes)	18.2	0.1			18.2	0.1
Anamolopidae (Flashlightfishes)			86.7	1.2	86.7	0.4
Holocentridae (Squirrelfishes)	93.8	0.7			93.8	0.4
Scorpaenidae (scorpionfishes)			22.5	0.3	22.5	0.1
Serranidae (Groupers)	2,453.9	17.7	11.2	0.2	2,465.1	11.6
Carangidae (Jack)	1,025.3	7.4	134.9	1.8	1,160.2	5.4
Coryphaenidae (Mahimahi)	117.2	0.8			117.2	0.6
Lutjanidae (Snappers)	2,279.4	16.5	7,102.3	96.0	9,381.7	44.2
Lethrinidae (Emperors)	5,948.3	43.0			5,948.3	28.0
Mullidae (Goatfishes)	376.3	2.7			376.3	1.8
Sphyrnaeidae (Barracudas)	205.9	1.5			205.9	1.0
Labridae (Wrasses)	357.9	2.6			357.9	1.7
Acanthuridae (Surgeon & unicornfishes)	63.0	0.5			63.0	0.3
Scombridae (Tunas)	62.0	0.4			62.0	0.3
Balistidae (Triggerfishes)	131.4	0.9			131.4	0.6
Triodontidae (Triplatooth)			24.1	0.3	24.1	0.1
SUBTOTAL	13,833.9	100.0	7,400.9	100.0	21,234.8	100.0
Undif.	492.1	3.4	48.2	0.6	540.3	2.5
TOTAL	14,326.0	65.8	7,449.1	34.2	21,775.1	100.0

Table 5. Estimated monthly and annual offshore spearfishing (with and without scuba) participation, effort, and catch during FY '91.

MONTH	PARTICIPATION		EFFORT		CATCH			
	no. of Persons	no. of Boat trips	no. of Person-hrs	no. of Boat-hrs	no. of Kilograms	Kg/ boat trip	Kg/ pers.-hr	Kg/ boat-hr
OCT	168.4	38.1	132.4	29.0	1,712.6	45.0	12.9	59.1
NOV	96.1	17.4	104.8	19.6	295.6	17.0	2.8	15.1
DEC	35.2	17.6	87.9	44.0	85.1	4.8	1.0	1.9
JAN	100.1	33.4	50.1	16.7	20.0	0.6	0.4	1.2
FEB	16.7	5.6	16.7	5.6	27.8	5.0	1.7	5.0
MAR	140.3	46.8	350.8	116.9	297.0	6.4	0.9	2.5
APR	221.7	67.1	708.4	209.0	1,919.1	28.6	2.7	9.2
MAY	376.3	120.8	679.5	218.8	2,240.2	18.5	3.3	10.2
JUN	327.5	221.9	1,244.1	377.1	7,492.5	33.8	6.0	19.9
JUL	439.2	366.5	1,879.2	674.7	4,094.6	11.2	2.2	6.1
AUG	321.7	64.3	321.7	64.3	207.2	3.2	0.6	3.2
SEP	0.0	0.0	0.0	0.0	0.0	-	-	-
TOTAL	2,243.2	999.5	5,575.6	1,775.7	18,391.7	18.4	3.3	10.4
GOES	3,262.8	1,010.4	5,658.8	1,797.0	18,375.0	18.2	3.3	10.2

Table 6. Estimated annual Guam offshore spearfishing participation, effort, and catch by method during FY '91.

A) PARTICIPATION:						
	No. of persons	SE	90% CL	No. of Boats	SE	90% CL
Snorkel	1,740.7	454.5	765.4	537.5	156.3	263.2
Scuba	1,494.3	373.8	629.5	463.6	118.2	199.0
Mixed	27.8	24.8	41.8	9.3	8.3	13.9
Total Spearfishing	3,262.8	853.1	1,436.7	1,010.4	282.8	476.1
B) EFFORT:						
	Person hours	SE	90% CL	Boat hours	SE	90% CL
Snorkel	3,652.4	979.5	1,649.4	1,192.4	363.1	611.4
Scuba	1,895.3	524.1	882.7	567.6	154.4	260.0
Mixed	111.1	99.4	167.4	37.0	33.1	55.8
Total Spearfishing	5,658.8	1,603.0	2,699.5	1,797.0	550.6	927.2
C) CATCH:						
	No. of Kilograms	SE	90% CL	Kg/ boat trip	Kg/ pers.-hr	Kg/ boat-hr
Snorkel	5,359.9	1,625.3	2,736.9	1.0	1.5	4.5
Scuba	12,235.5	3,940.4	6,635.7	26.4	6.5	21.6
Mixed	779.6	697.3	1,174.3	83.8	7.0	21.1
Total Spearfishing	18,375.0	6,263.0	10,546.9	18.2	3.3	10.2

Table 7. Composition of the Guam spearfishing catch during FY '91. Percentages of finfishes are of the differentiated portion of the catch only.

TAXON	SNORKEL		SCUBA		MIXED		TOTAL	
	Kg	%	Kg	%	Kg	%	Kg	%
FISHES								
Holocentridae (Squirrelfishes)	61.7	1.5	34.7	0.3	13.4	7.7	109.8	0.7
Serranidae (Groupers)	149.7	3.7	961.3	8.8			1111.0	7.3
Priacanthidae (Bigeyes)			5.7	0.1	5.5	3.1	11.2	0.1
Carangidae (Jacks)	6.9	0.2	62.1	0.6	1.5	0.9	70.5	0.5
Lutjanidae (Snappers)	95.0	2.3	576.7	5.3	27.9	16.0	699.6	4.6
Caesionidae (Fusiliers)			11.9	0.1			11.9	0.1
Haemulidae (Sweetlips)	22.1	0.5	186.4	1.7	18.5	10.6	227.0	1.5
Lethrinidae (Emperors)	129.8	3.2	212.6	1.9			342.4	2.3
Mullidae (Goatfishes)	63.1	1.6	165.8	1.5	12.4	7.1	241.3	1.6
Pempheridae (Sweepers)	6.6	0.2					6.6	0.0
Kyphosidae (Rudderfishes)	135.0	3.3	147.5	1.3	10.3	5.9	292.8	1.9
Ephippidae (Spadefishes)					40.9	23.4	40.9	0.3
Chaetodontidae (Butterflyfishes)	5.3	0.1					5.3	0.0
Cirrihitidae (Hawkfishes)	7.7	0.2					7.7	0.1
Mugilidae (Mulletts)	105.0	2.6					105.0	0.7
Sphyraenidae (Barracudas)			54.5	0.5			54.5	0.4
Labridae (Wrasses)	302.8	7.5	839.1	7.6	17.1	9.8	1,159.0	7.6
Scaridae (Parrotfishes)	1,969.1	48.7	5,078.4	46.3	6.0	3.4	7,053.5	46.4
Acanthuridae (Surgeonfishes)	791.2	19.5	2,522.4	23.0	21.4	12.2	3,335.0	21.9
Siganidae (Rabbitfishes)	49.4	1.2	112.9	1.0			162.3	1.1
Balistidae (Triggerfishes)	20.8	0.5					20.8	0.1
Monacanthidae (Filefishes)	75.2	1.9	4.8	0.0			80.0	0.5
Tetraodontidae (Puffers)	50.9	1.3					50.9	0.3
Differentiated fishes subtotal	4,047.3	80.9	10,976.8	96.4	174.9	100.0	15,199.0	91.7
Undifferentiated fishes	957.1	19.1	412.7	3.6			1,369.8	
Fishes subtotal	5,004.4	93.4	11,389.5	93.1	174.9	22.4	16,568.8	90.2
INVERTEBRATES								
Gastropods	3.3	0.9	0.7	0.1	604.7	100.0	608.7	33.7
Cephalopods	193.6	54.4	50.1	5.9			243.7	13.5
Spiny lobsters	143.6	40.3	773.5	91.4			917.1	50.8
Slipper lobsters			8.7	1.0			8.7	0.5
Crabs	15.5	4.4	13.1	1.5			28.6	1.6
Invertebrate subtotal	356.0	6.6	846.1	6.9	604.7	77.6	1,806.8	9.8
TOTAL (All species)	5,360.4	100.0	12,235.6	100.0	779.6	100.0	18,375.6	100.0

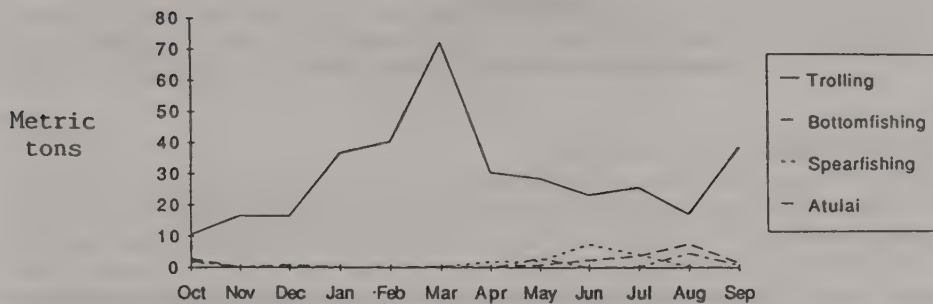
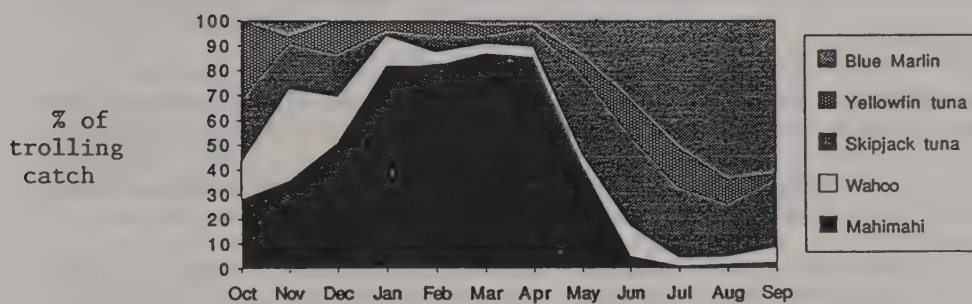
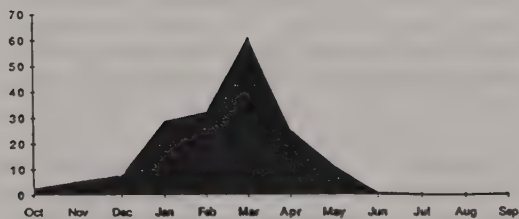


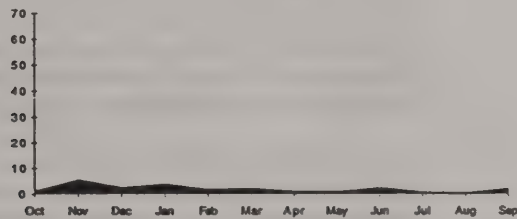
Figure 1. Estimated monthly landings for Guam small boat offshore fisheries during FY91.



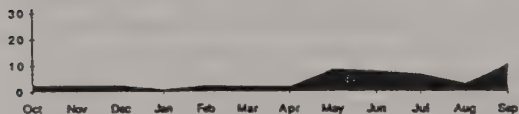
a. Catch composition by weight



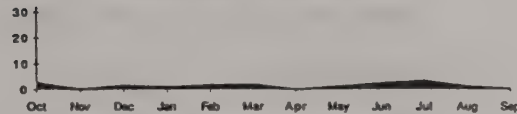
b. Mahimahi



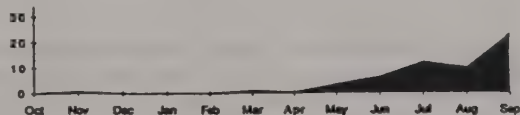
c. Wahoo



d. Skipjack tuna



e. Yellowfin tuna



f. Blue marlin

Figure 2. Estimated monthly landings for Guam's major troll-caught species during FY91. All figures except 2a are in metric tons.

APPENDIX I

Guam International Fishing Derby

PERIOD COVERED: 19-21 July, 1991

INTRODUCTION

The fifteenth Guam International Fishing Derby (GIFD), sponsored by the Guam Visitors Bureau (GVB), was held on July 19, 20, and 21, 1991. Awards were presented to the anglers who landed the first, second, third, and fourth heaviest fishes of the following species: blue marlin (*Makaira nigricans*), yellowfin tuna (*Thunnus albacares*), wahoo (*Acanthocybium solandri*) and mahimahi (*Coryphaena hippurus*). Awards were also given for the largest fish caught in a ladies category, in a children under age 16 category, and in a tourist category. Records were kept in an "other species" category by the DAWR.

PROCEDURES

In theory, the determination of GIFD statistics is based on complete catch reports from all participating boats and requires no expansion, but in practice, there are always a significant number of boats that do not provide catch information. Since the GOES Tournament Module requires a complete data set, it has not been used, and the estimated derby parameters were added to the GOES monthly and annual output by hand.

DAWR biologists were present at the single onshore check-out/check-in station at the Agat Marina. The Agana Boat Basin and Merizo Pier were not included in the GIFD due to logistic constraints and safety considerations. This was the first GIFD that was not held at the Agana Boat Basin. A log of all departing and returning boats was kept and as many returning boats as possible were intercepted for interviews.

Parameters of participation and effort were determined by using daily averages in place of missing data wherever possible. This was done for number of fishermen, number of lines fished, and "down time" when determining hours spent fishing. For these parameters, daily data was missing for approximately 15 to 40% of returning boats, depending on the parameter and day. The number of boat trips and boat hours was known since a log of all departing and returning boats was kept.

Determination of catches required a subjective appraisal of what species were likely to be present in non-intercepted boats. Average daily catch rates by species were assigned to non-intercepted boats in order to determine daily totals. Catches of non-intercepted boats were assumed to contain only non-derby species. The proportion of returning boats intercepted ranged from 81% on the second day to 90% on the third day of the derby.

RESULTS

Participation

Eighty-two boats made 206 fishing trips during the course of the derby. This was 33% and 36% less than during last year's derby, respectively, but slightly more than the numbers of boats and trips for the 1989 GIFD. There were an average of 3.8 anglers pulling an

average of 4.2 lines per trip. The mean time spent on the water was 9.6 hours per boat trip, of which 9.1 hours were spent fishing. These figures are somewhat higher than those of the last two years.

Catch

The 4,656 kg of derby species was 8% more than the 4,317 kg landed during last year's GIFD, but 26% less than the record 6,274 kg landed during the 1989 GIFD (Tables 2, 3). The vast bulk (67%) of the catch consisted of blue marlin (3,103 kg). Including the by-catch, which accounted for 48% of the fishes but only 11% of the weight, 412 fish weighing 5,204 kg were caught. This is also the lowest total since 1986.

The mean catch per boat per trip was 25.3 kg., 45% more than the catch rate of last year's derby, but 41% less than the record catch rate of the 1989 GIFD. Like the overall catch rate, the catch rates for each of the derby species except mahimahi were higher than those of last year's derby (Table 3). The catch rate for blue marlin was 23% greater than that of last years derby and greatly exceeded those for all other species (1.65 vs 0.06 to 0.60 kg/boat-hour fished).

Sixty-one blue marlins, weighing 3,102 kg, were landed during the 1991 GIFD. This was the lowest total weight since 1986. The mean weight of 50.8 kg was the smallest in derby history and the 111.1 kg winning fish was smallest for all years except 1978.

The catch of 102 yellowfin tuna was slightly higher than in each of the last two years, but the total weight (1,129 kg) was the highest since 1982 and the mean size (7.9 kg) the highest since 1983. This reverses an apparent downward trend in size over the last several years.

The catch of 40 wahoo weighing 317 kg was higher than that of last year, but lower than that of several recent years. The winning wahoo of 24.0 kg was the second highest in the history of the GIFD.

The mahimahi catch of 11 fish was fairly typical, but the total weight (108 kg) was the third largest on record. The 18.5 kg winning fish set a new derby record.

At least six "non-derby" species were landed, accounting for slightly less than half of the individual fishes (48%) but only 11% (548 kg) of the overall derby catch. The bulk of this consisted of skipjack tuna (318 kg) with the remainder consisting of 231 kg of shark, barracuda, kawakawa, dogtooth tuna, and rainbow runner.

Fishing areas

Useable locality data was obtained from 51% of the returning boats. This made it possible to compare catches and catch rates by area (Table 4). However, the small number of trips to some areas makes certain comparisons highly subjective. This was the first year in which most of the fishing effort was spent south of Agat Marina (all or part of 66% of the boat trips vs 37% north of Orote Pt.). Slightly more than half (51%) of the boats fishing to the south fished one or more of the southern banks, with Galvez Bank being the most frequently visited. Most of the catch was also from the south, as well as the best overall catch rates for each of the derby species. This year the best fishing for marlin, yellowfin tuna, and mahimahi was around Guam's southern banks. Although the catch rate for wahoo was slightly better around the Tarague to Pati Point area than the southern banks, this was based on only two boats reporting from the northern area, so the comparison is meaningless. Otherwise the catch rate for wahoo was considerably better around the

southern banks than any other area. Overall catch rates for all derby species except mahimahi as well as for most areas were higher than those of last year, as well as the year before for marlin and yellowfin tuna. The pattern of highest catch rates in the south differed from that of last year, but was consistent with the four preceding years.

ACKNOWLEDGEMENTS

The fisheries staff of the Division of Aquatic & Wildlife Resources (DAWR) wish to thank the competing anglers, the Guam Visitor's Bureau, and members of the fifteenth GIFD derby committee for their cooperation and assistance in providing the information that made this report possible. This cooperation not only makes our job easier and more enjoyable, but insures a more accurate collection of data and better information for the fisherman.

Report prepared by Robert F. Myers

Table 1. Daily participation, effort and catch in the fifteenth annual Guam International Fishing Derby. Weights are expressed in kilograms (1 kg = 2.2046 lbs).

	DAY 1 JUL 19	DAY 2 JUL 20	DAY 3 JUL 21	DERBY TOTALS
Number of boats	68.00	66.00	63.00	82.00
Number of boat trips	71.00	68.00	67.00	206.00
Number of fishermen*	202.00	186.00	198.00	586.00
Average number of men per boat	2.80	2.70	3.00	2.80
Number of lines fished**	299.00	293.00	282.00	874.00
Average number of lines per boat	4.20	4.30	4.20	4.20
Boat hours	717.20	649.40	602.30	1,968.90
Fished hours	674.20	629.90	572.20	1,876.30
Average boat trip length	10.10	9.60	9.00	9.60
Average time spent fishing	9.50	9.30	8.60	9.10
Fisherman hours	1,913.40	1,719.70	1,689.70	5,322.80
Line hours†	2,836.40	2,714.90	2,406.00	7,957.30
Number of fish landed	175.00	133.00	103.00	411.00
Catch landed (kg)††	2,007.20	1,681.70	1,516.10	5,205.00
Kg/boat	29.52	25.48	24.06	63.48
Kg/boat trip	28.27	24.73	22.63	25.27
Kg/boat hour	2.80	2.59	2.51	2.64
Kg/man hour	1.04	0.98	0.90	0.98
Kg/line hour	0.71	0.62	0.63	0.65

* Daily total assumes no turnover of participants for boats with multiple trips per day; derby total is given as 100% turnover.

** Artificial data based on the average number of lines per boat interviewed multiplied by the number of boats.

† Based on actual time spent fishing and overall average number of lines per boat.

†† Includes incidental catch of non-derby species.

Table 2. Daily catch composition for the fifteenth annual Guam International Fishing Derby. Weights are expressed in kilograms.*

SPECIES	DAY 1 - JUL 19			DAY 2 - JUL 20			DAY 3 - JUL 21			DERBY TOTALS		
	NUMBER CAUGHT	TOTAL WT.	AVG WT.	NUMBER CAUGHT	TOTAL WT.	AVE WT.	NUMBER CAUGHT	TOTAL WT.	AVE WT.	NUMBER CAUGHT	TOTAL WT.	AVE WT.
Derby												
Blue marlin	23	1,113.0	48.4	19	1,022.2	53.8	19	967.6	50.9	61	3,102.9	50.9
Yellowfin tuna	56	578.6	10.3	25	324.6	13.0	21	226.1	10.8	102	1,129.3	11.1
Wahoo	9	67.0	7.4	17	126.6	7.4	14	123.2	8.8	40	316.7	7.9
Mahimahi	6	59.4	9.9	3	38.6	12.9	2	9.8	4.9	11	107.8	9.8
Non-derby												
Skipjack tuna	51	135.5	2.7	9	60.0	6.7	27	122.1	4.5	87	317.6	3.7
Kawakawa	6	11.3	1.9				6	8.6	1.4	12	19.9	1.7
Dogtooth tuna	2	8.1	4.0				1	7.6	7.6	3	15.7	5.2
Shark				1	16.8	16.8	1	7.0	7.0	2	24.3	11.9
Rainbow runner	15	16.9	1.1	56	81.6	1.5	6	6.2	1.0	77	104.7	1.4
Barracuda	6	17.5	2.9	4	11.2	2.8	7	37.8	5.4	17	66.5	3.9
TOTALS	174	2,007.3	88.6	134	1,681.6	114.9	104	1,516	102.3	412	5,205.4	107.5

* Figures for non-derby species of which more than one were known to have been caught are based on an expansion that accounts for returning vessels that were missed. Expanded numbers of fishes are rounded to the nearest whole number.

Table 3. Catch comparison for all Guam International or Marianas Fishing Derbies¹. Weights are expressed in kilograms (1 kg=2.2 046 lbs).

	1977	1978	1979	1980	1981	1982	1983	1984 ²	1985	1986	1987 ³	1988	1989	1990	1991
BLUE MARLIN															
no. caught	9	9	6	12	34	12	13	47	17	47	43	58	86	64	61
total weight	932.9	511.1	702.9	727.0	2,005.0	852.2	964.2	2,840.4	1,659.0	2,859.0	4,008.2	3,831.9	5,263.6	3,398.9	3,102.3
ave. weight	103.6	56.8	117.2	60.6	59.0	71.0	74.2	60.4	97.6	60.8	93.2	66.1	61.2	53.1	50.8
winning fish	191.8	75.3	237.2	138.8	145.1	132.0	199.1	215.4	177.8	173.7	188.2	155.3	182.2	133.8	111.1
YELLOWFIN TUNA															
no. caught	18	11	34	50	109	205	100	59	137	71	116	161	81	81	102
total weight	239.9	254.9	637.2	307.9	1,156.0	2,376.9	1,105.7	388.8	1,058.0	405.9	858.5	848.5	385.2	546.3	1,129.1
ave. weight	13.3	23.2	18.7	6.2	10.6	11.6	11.1	6.6	7.7	5.7	7.4	5.3	4.8	6.8	7.9
winning fish	46.3	56.7	67.6	51.2	47.6	61.2	55.8	51.7	45.8	45.8	26.8	44.9	21.5	39.9	57.8
WAHOO															
no. caught	7	9	11	12	60	33	36	46	98	16	31	72	59	34	40
total weight	90.7	102.0	116.1	161.0	542.9	263.9	359.6	466.2	921.5	136.5	314.3	567.4	588.1	249.7	316.7
ave. weight	13.0	11.4	10.5	13.4	9.0	8.0	10.0	10.1	9.4	8.5	10.1	7.8	10.0	7.3	7.9
winning fish	22.2	19.0	19.5	23.6	16.8	22.7	24.5	21.3	23.6	17.7	16.8	22.4	17.9	17.6	24.0
MAHIMAH															
no. caught	2	4	5	3	1	14	33	0	14	7	3	5	7	25	11
total weight	13.6	26.3	52.6	39.5	0.9	63.5	195.0	0.0	76.6	61.7	39.9	12.2	36.9	121.6	107.8
ave. weight	6.8	6.6	10.5	13.1	0.8	4.6	5.9	0.0	5.5	8.8	13.4	2.4	5.3	4.9	9.8
winning fish	9.1	9.1	15.0	15.9	0.9	15.0	10.9	0.0	15.0	14.5	15.4	4.3	18.4	10.8	18.5
DERBY SPECIES															
no. caught	36	33	56	77	177	291	182	152	266	141	193	296	233	205	214
total weight	1,277.6	894.3	1,508.4	1,235.4	3,704.8	3,556.9	2,624.5	3,695.2	2,716.1	3,463.5	5,220.9	5,260.0	6,273.8	4,316.6	4,655.9
most per boat											57	42	26		
TOTAL CATCH															
no. caught							281	336	427	237	488	993	562	623	412
total weight	0.0	0.0	0.0	0.0	0.0	0.0	3,277.6	4,365.1	4,370.1	3,794.1	6,668.5	8,188.4	7,969.8	5,646.8	5,203.9

¹Based on returned catch reports for 1977 to 1983, but includes estimated bicatch and unreported catches for 1984 to present. Only the principal derby species are reported for 1977 to 1982.

²Based on known catches of principle derby species and estimated catches of non-derby species expanded for non-reporting boats.

³Figures for blue marlin and yellowfin tuna originally reported are in error. The corrected figures are given here.

⁴Includes 2 sailfish weighing a total of 124.3 lbs in 1989 and 1 sailfish weighing 66.0 lbs in 1990.

⁵Includes all tuna species.

Table 4. Effort, catch, and catch rates by area for the fifteenth annual GIFD. Effort is based on the number of boat trips in which area fished was reported and includes all boats known to have fished within a given area. A small number of catches from unspecified areas are not included.

Area	Effort (number of boat trips)	Blue marlin		Catch Yellowfin tuna		Wahoo		Mahimahi		Blue marlin		Catch rate (no. and lbs./trip) Yellowfin tuna		Wahoo		Mahimahi	
		no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.
North	39	11	523.0	9	211.1	3	31.0	-	-	0.28	13.4	0.23	5.4	0.08	0.8	-	-
NW Guam ¹	39	9	414.1	5	99.2	3	31.0	-	-	0.23	10.6	0.13	2.5	0.08	0.8	-	-
N. Banks	7	2	107.7	1	15.0	-	-	-	-	0.29	15.4	0.14	2.1	-	-	-	-
NE Guam ²	2	1	100.0	1	3.6	1	13.3	-	-	0.50	22.7	0.50	1.8	0.50	6.7	-	-
Rota	1	-	-	1	4.5	-	-	-	-	-	-	1.00	4.5	-	-	-	-
South	69	31	1,571.2	50	555.9	20	166.0	5	48.8	0.45	22.8	0.72	8.1	0.29	2.4	0.07	0.7
SW Guam ³	69	7	354.0	3	111.4	3	37.9	-	-	0.10	5.1	0.04	1.6	0.04	0.6	-	-
S. Banks	35	21	1,018.0	44	410.7	17	127.9	3	27.1	0.60	29.1	1.26	11.7	0.49	3.7	0.09	0.8
SE Guam	3	1	63.0	3	29.3	-	-	-	-	0.33	21.0	1.00	9.8	-	-	-	-
Total	105	42	2,094.1	59	767.1	23	197.0	5	48.8	0.40	19.9	0.56	7.3	0.22	1.9	0.05	0.5

¹ Agat Marina to Ritidian Pt.

² Tarague to Pati Pt.

³ Agat Marina to s. tip of Cocos Is.

APPENDIX II

Z-Best Fishing Derby

PERIOD COVERED: 21-23 September, 1991

INTRODUCTION

The second annual Z-Best Fishing Derby, sponsored by the Z Fishing Company was held on September 21, 22, and 23, 1991 at the Agat Marina. Although this was the largest derby of FY'91 in terms of participation, the Division of Aquatic & Wildlife Resources (DAWR) was unable to devote the manpower to monitor it. However, sufficient information was recorded by the Z-Best Company to estimate catches of targeted species. The Z Fishing Company kindly provided this information to the DAWR to make this report possible. Awards were presented to the anglers who landed the first, second, third, and fourth heaviest fishes of the following species: blue marlin (*Makaira nigricans*), yellowfin tuna (*Thunnus albacares*), and skipjack tuna (*Katsuwonus pelamis*). The largest individual or individuals of each species for each boat trip were recorded.

PROCEDURES

The only known quantities were the number of boats participating in the derby on each of the three days, the number of parked trailers and empty boat slips at the Agana Boat Basin at a given time during the afternoon of each derby day, the individual weights of the entered fishes, and the fact that few if any charter boats participated. Therefore several assumptions had to be made in order to factor the derby into the expanded September results.

An instantaneous count of boat trailers and empty non-charter boat slips was taken at the Agana Boat Basin during mid afternoon of each of the three derby days for comparison with the non-derby survey days. The results indicated that the derby did not result in a reduction in the non-charter or charter boat activity at the Agana Boat Basin, therefore results of the derby were added to a 30-day September expansion.

Since the only measure of participation or effort was number of boats entered per day and most derby participants make one trip per day, the number of boat trips was assumed to be the same as the number of boats entered. It was also assumed that the amount of time per trip spent fishing, the number of lines used, and the number of people per boat were the same for the derby as for the September survey.

Based on experience at other derbies, and the relatively small sizes of the winning fishes, it was assumed that most if not all marlin caught were entered. However since several skipjack tuna and smaller yellowfin tuna are often caught on a given trip, and only a few boats entered more than one fish on a given day, it was assumed that many individuals of these species were not entered. Therefore the September catch rate (kg/boat trip) was used to estimate the weight of skipjack tuna caught during the derby. However, the September catch rate for yellowfin tuna was lower than that of the derby based on entered fish, so the weight of the entered fish was accepted for that species. Catch rates for incidental species were assumed to be the same as the survey results.

RESULTS

The following results were determined using the procedures outlined above:

Participation:

Boat trips:	269
Persons:	1,450.1

Effort:

Boat hours:	1,119.0
Person hours:	6,058.2

<u>Catch (kg):</u>	<u>Est. landings</u>	<u>Winning Fish</u>
Skipjack tuna	1,847.1	94.3
Yellowfin tuna	433.3	44.4
Blue Marlin	1,417.1	9.2
Mahimahi	152.5	
Wahoo	420.5	
Kawakawa	56.5	
Total	4,327.0	

These results were added to the GOES 30-day September expansion.

ACKNOWLEDGEMENTS

The fisheries staff of the DAWR wish to thank the Z Fishing Company for providing the information on participation and entered catches as well as the volunteers, supporting businesses, and participants for their cooperation.

Report prepared by Robert F. Myers

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: F-1

STUDY NO.: 1

JOB NO.: 2

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October, 1990 to September, 1991. The total estimated inshore fisheries catch for this time period was 141.5 mt, 97.36% of which were finfish. Hook and line was the most popular method accounting for 70.20% of the total participation* or 49,365 participants. Drag net fishing was the most successful method (day, night and combined) in terms of catch rate, yielding approximately 3.36 kg/gear-hour and a harvest of 0.6 mt. The seasonal fisheries (scads and manahac) accounted for 51.93% of the total finfish harvest or 73.5 mt.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational/subsistence fishing activities have come to be based on more reliable data analysis techniques.

OBJECTIVES

1. To estimate the total annual inshore participation, effort and harvest of Guam's inshore recreational/subsistence fisheries through statistically valid surveys and analysis.
2. To gather limited biological data that will add to a long-term historical data base on Guam's important inshore fish species.

PROCEDURES

During FY91, day and night "inshore participation" surveys were conducted on four randomly selected days per month. These surveys entailed making visual observations of not only participation among the various fishing methods employed but also of the reef zones and general locations that were fished within the more readily accessible portions of Guam's coastline (Fig. 1, locations 1-71). Based on data collected during ten non-

* All participation and effort statistics except total harvest exclude seasonal fisheries data.

consecutive years of aerial surveys conducted between FY63 and FY90, approximately 85% of Guam's inshore fishing activities is known to occur within this area. The starting location for each survey was selected at random and the "circular" direction of driving was alternated between surveys. This was modified slightly due to road construction and closure between Agat to Umatac, beginning January, 1990. The route, until reopening of the road in June, 1991, alternated days between Agat (starting at Agat driving clockwise to Umatac) and Umatac (starting at Umatac and driving counterclockwise to Agat). Observations were made while driving the route once without backtracking. These methods were applied for both day and night participation surveys from January 1990 through May 1991. During June, upon reopening of the road, the survey procedure returned to the randomly selected, alternating "circular" direction of driving.

In addition, four "inshore-catch" survey days were selected. During these catch days, a fisherman-intercept survey was conducted to gather catch, effort, and species composition data for both day and night fishing. The day survey covered a six-hour interval (starting at 0630 hours) and the night survey covered a five-hour interval (starting at 1900 hours). Only one of three survey regions (Fig. 1) was selected for each "inshore-catch" day and fisheries data collection was restricted to that region. However, because of infrequently used methods (i.e., drag net, spear-scuba, surround net), representative samples were sometimes difficult to obtain. Therefore, if a particular fishing method was not observed within the selected survey area during a survey, one of the other two areas could be searched.

Seasonal data (tiao' and e'e') was acquired through actual participation and catch surveys. Because of the lack of information during these surveys on other seasonal fish (fusiliers, scads and manahac), catch information was obtained through incidental interviews with fishermen, conversations with village mayors, DAWR Conservation Officers and other biologists.

Because the coastal fishing participation and range has steadily increased over recent years, aerial surveys were reinstated around Guam during FY90 and were continued during FY91, in order to update island wide participation estimates. Aerial surveys were begun in October, 1989 and conducted twice monthly. The surveys were performed on regularly scheduled participation days (one weekend and one weekday) and began on the hour, rotating through from 0800 to 1200 for each subsequent survey. Visual observations of the fishing methods, participants, gear units and areas fished were recorded as done in the inshore participation survey. Other data collected during these flights include observations of marine mammals and turtles, offshore fishing activity, FAD (fish aggregation device) use and other incidental information.

The FY91 inshore harvest estimates were calculated by a computer software package known as the Guam Inshore Expansion System (GIES). The GIES utilizes formulae described in the FY85 project report (Project No. FW-2R-22, Sub-Project F, Study No. F-1, Job No. 2).

RESULTS

During FY91, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 141.5 mt. Finfish accounted for 97.36% of the total harvest, or 137.7 mt. Aside from these two initial statements for the purposes of comparison to past reports, when catch or effort statistics of the inshore fishery are reported, the seasonal harvest (scads, manahac and fusiliers) has not been included because these are sporadic fisheries. The total fish catch (finfish and non-finfish) resulted from a total effort of 234,062 person-

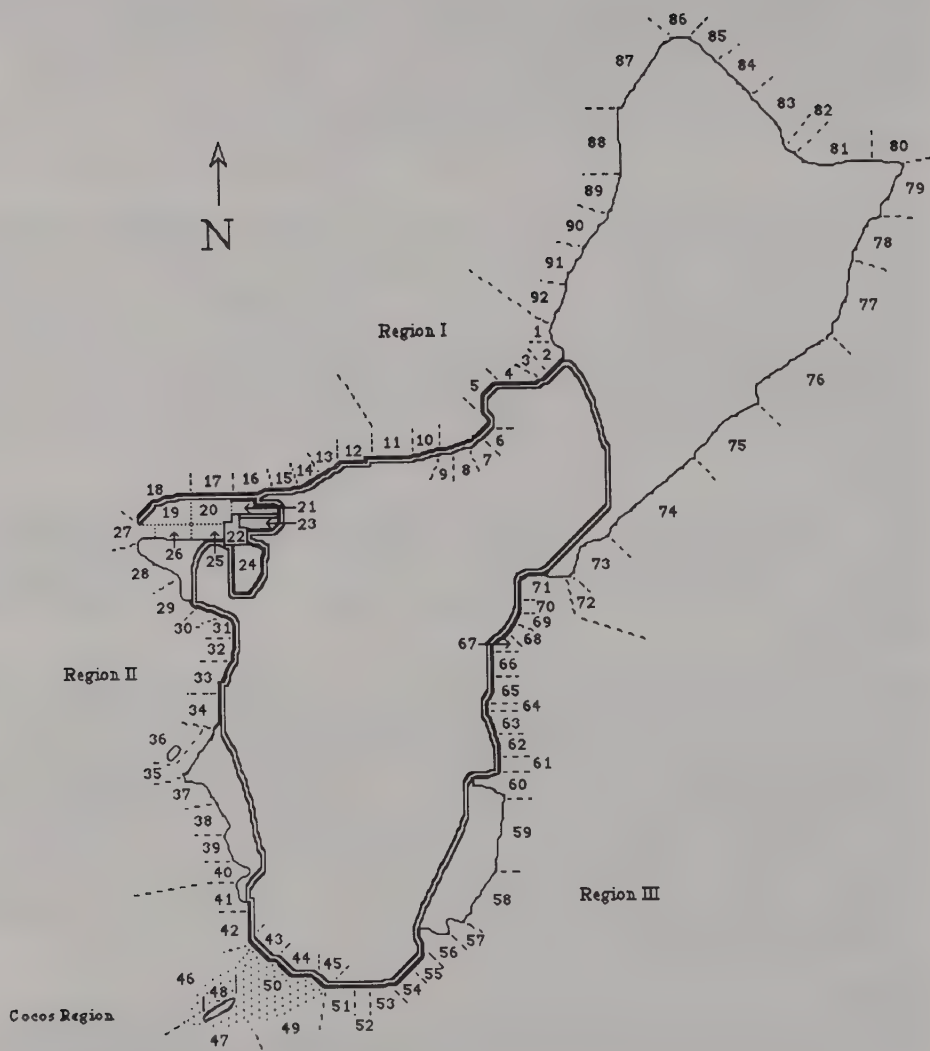


Figure 1. Inshore Fisheries "Participation Survey" Route and Location Codes.

hours and 211,416 gear-hours. Overall, approximately 0.67 kg of fish were taken per gear-hour. Estimated participation, effort, and catch values for each fishing method for day, night and combined (total) are shown in Table 1.

An increase in the total harvest (fin and non-finish) was seen in FY91 (68.0 mt, 141.5 mt with seasonal included) compared to FY90 (43.1 mt, 54.1 mt with seasonal included). The number of participants and gear-hours increased slightly from FY90 to FY91, but are probably not significantly different due to the large coefficient of variance observed in some of the methods. The increase in total expanded catch in FY91 can be mostly attributed to the good harvest of the seasonal fisheries (tiao', e'e, and scads). Part of this is seen by the increase in hook and line for the scad from FY90 (188.6 kg) to FY91 (11,901.2 kg). Other juvenile catches (tiao', e'e', aguas) showed similar increases from FY90.

Effort

Hook and line fishing was, by far, the most popular method based on the total participation (combined day and night values), accounting for 49,365 persons or approximately 70.21% of the total participation. Gill netting was the second most popular method overall accounting for 9,432 participants or 13.41% of the total participation, while cast netting followed with 7,778 participants or 11.06% of the total.

The rank order for day fishing participation placed hook and line first with more than 4.9 times as many participants as any other method, 37,662 (70.40%) participants. Cast net and gill net placed second and third respectively with 7,663 (14.33%) and 6,225 (11.64%) participants.

Hook and line remained the most popular night fishing method with 11,702 participants and 69.59% of night participation. The second most popular method was gill net fishing with 3,207 participants or 19.07% of night fishing, while spear fishing with snorkel gear followed with 1,233 participants or 7.33% of night fishing.

Catch

Finfish made up 94.51% or 64.2 mt (97.36% or 141.5 mt with seasonal included) of the total (day and night) harvest. Hook and line fishing yielded the largest harvest overall of 28.1 mt or 43.67% of the total finfish harvest. Gill net fishing ranked next with 18.0 mt or 27.99% followed by cast net fishing with 10.7 mt or 16.66 % of the overall total.

Due to more than 80% of the total harvest resulting from day fishing, the rank order for day harvest did not vary from that of the combined harvest with the percent harvest falling near 85% for the top three methods. Hook and line fishing yielded the largest harvest overall of 24.9 mt or 46.22% of the day finfish harvest. Gill net fishing followed with 12.7. mt or 23.52% and cast net fishing was third with 10.7 mt or 19.76 % of the day harvest.

Finfish made up 93.96% of the total night harvest with gill net fishing having the highest catch of 5.3 mt or 51.39%. Hook and line ranked next with 3.1 mt (30.32%) followed by spearfishing with snorkel gear with 1.2 mt or 11.91%.

Catch Per Unit Effort (CPUE)

The largest combined (day and night) CPUE effort was seen by drag net fishing (3.36 kg/gear-hour) followed by surround net fishing (2.94 kg/gear-hour). Third place was shared with the CPUE only slightly higher for gill net fishing (1.08 kg/gear-hour) than spear fishing with snorkel gear (1.06 kg/gear-hour).

Drag net fishing, historically a nighttime fishing method, had the highest daytime CPUE of 3.11 kg/gear-hour. Surround net fishing followed with 2.94 kg/gear-hour and spearfishing with snorkel gear was third with 1.62 kg/gear-hour.

Drag net fishing had the highest nighttime CPUE of 3.36 kg/gear-hour for night fishing. Hook and gaff fishing followed with 1.61 kg/gear-hour and gill net fishing was third with 1.25 kg/gear-hour.

The information concerning effort and harvest for methods not discussed are included in the summary Tables 1.

Other nearshore fisheries harvests (including spearfishing, hook and line, net fishing) are recorded on Guam and those results appear in the Offshore Fisheries Report (Project No. FW-2R-26, Sub-Project F-1, Study No. 1, Job No. 1) due to fishing done with a "trailerable boat."

The species composition for the FY91 expanded harvest for day, night, and combined are presented in Tables 2-4. The top day (as well as combined day and night) caught species was *Selar crumenophthalmus* (atulai), one of several seasonal fish caught in FY91 and was taken by hook and line and several types of net fishing. The top night-caught species was *Acanthurus triostegus* (kicho), which was taken primarily by net fishing (cast and gill net) and spear fishing with snorkel gear.

In general the top ten families remained the same as those in FY90 with some shifts in rank order. Holocentrids ranked in the top ten, as in previous years replacing serranids. The harvest estimates for the top families fluctuated with some being higher than FY90 (acanthurids, kyphosids, siganids, carangids and mullids) while others dropped slightly (muglids, lethrinids and lutjanids). A drop in harvest for most of the families continued from FY89 with the exception of kyphosids and carangids (which increased) and muglids (which remained relatively the same). Some of the differences in harvest can be attributed to a good year for seasonal or juvenile fish, other than scads (carangids, mullids, and muglids) and can be better analyzed through specific species differences in the day and night catch.

Much of the combined harvest ranking can be explained by the 80% composition of the day harvest. The harvest estimates of the day time top families showed similar catch rates compared to previous years as discussed above. Labrids ranked in the top ten, displacing lutjanids, and gerreids did not rank for the second year. *Kyphosus cinerascens* (guili) and *Siganus spinus* (sesjun) placed second and third in the day species ranking following *Selar crumenophthalmus*. The change in the ranking of kyphosids may be skewed because of the large cast net catches reported in the creel survey. One of the primary method of harvest occurs outside our survey time (usually 0200 through 0500 on a full moon). Because this catch time is not surveyed, this may indicate the harvest of this species is more important than the expansion has previously documented. Changes in ranking (decline of *Mulloides flavolineatus*) may be due to the higher number of juveniles targeted therefore resulting in a decrease in overall catch and not number. *Lutjanus bohar* (tagafi), that appeared for the first time in FY90 rankings, dropped from FY91 and can be attributed in part, to the methodology (number of sample days). The drop of *Gerres argyreus* and *Liza vaigiensis* from the top ten to 15th and 18th, respectively, should be monitored. The lack of a *Lethrinus* species not ranking in the top ten since FY88 should also be evaluated, along with offshore catches, to determine if changes in inshore species composition have occurred because of boat catches.

The composition of the families for the nighttime fishing methods remained relatively the same with some shifts and changes in rankings. The harvest estimates were similar to FY90, but were less than FY89 and FY88. Sphyraenids made their first appearance in the top ten primarily due to the ranking of *Sphyraena barracuda* (alu) in the species ranking. The catches of muglids and mullids stayed about the same as FY90, even though FY91 saw higher numbers of juveniles caught. Scarids (and *Scarus sordidus*) ranked in the top ten for the first time since FY86. Part of this change in the ranking is due to the higher number of participants for both gill net and spear with snorkel fishing as well as higher number of catch interviews for these methodologies. The scarids have previously been a major contributor to the night harvests. Investigation comparing past years database with offshore catches along with size distribution of catches should be continued to further explain past differences. Lethrinids fell to number ten ranking with the lowest catch reported similar to that of FY88 (0.4 mt). The lack of a lethrinid species ranking in the top ten of the nighttime species ranking accounts for this displacement. *Gerres argyreus* (guaguas) also dropped from the top ten ranking (5th to 27th). Because of the importance of these species, this should be further investigated and closely monitored for signs of overfishing.

Some of the major shifts in rank order of harvest value for species and family groups may have resulted from the shift in importance of method participation (targeting seasonal harvest). The shift in importance between fishing methods toward hook and line continued in FY91. This still may be a function of methodology and data collection technique but a large portion of this year's hook and line participation targeted primarily seasonal carangids (both scads and e'e'). Some of the other shifts (i.e., drag net fishing during the daytime) suggest that fishing effort continues to shift toward harvest methods with higher catch rates. These changes should be investigated to determine if subsistence or commercial fishing is the cause of these differences. With net fishing having the highest CPUEs and with some of the observed changes in family and species rankings (possibly due to smaller size classes of fish being caught) these methods, especially commercial gill net use, require management to prevent overfishing.

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The catches of tiao' and e'e' are usually well represented within the expansion estimates (Tables 1). During FY91, pulses of recruiting juvenile jacks (e'e') occurred from May through September with juvenile goatfish (tiao') and mullet (aguas) also, observed caught. The seasonal harvest for these species was better than FY90 and continued through the end of the fiscal year for the goatfish.

Three specific seasonal fisheries require special mention, *Selar crumenophthalmus* (atulai), *Siganus spinus* (sesjun) and *Pteroceasio tile*. FY91 marked an exceptional year for scads (*Selar crumenophthalmus*) with the FY90 season extending well into April 1991. The season began again in July 1991 and was still occurring at the end of the fiscal year. Atulai represented the largest combined and day caught species with 84,529.0 kg. During FY91 the manahac (juvenile rabbitfish) did not run in large numbers. FY '91 showed more manahac caught (840.9 kg) than in the FY90 (172.7 kg) but less than FY89 (1,500 kg). The last large run of manahac was seen in FY88 when 29,000 kg was caught. The harvest estimates for these fisheries were determined independently from the GIES system due to the sporadic nature of these fisheries.

In addition to finfish, a number of other organisms were taken from the reefs throughout the year. The top day harvest was of strombids (1,886.7 kg) while the Trochus was the top night harvested species (421.4 kg). A total of 690.5 kg of Trochus was harvested for combined day and night. The estimated harvest of octopus amounted to a 1,207.4 kg (0.41 kg/gear-hour) primarily by hook and gaff kg and was caught at the rate of 0.42 kg/gear-

hour. Beyond this, the "other methods", such as gleaning, produced an estimated 3.0 mt of various marine algae, crustaceans, gastropods, and bivalves with a catch rate of 0.57 kg/person-hour of fishing effort. Adding the total non-fish harvest of 3.7 mt, brings the total island inshore harvest to 68,000.8 kg (141,469 kg with seasonal included).

Aerial Surveys

Aerial observations of fishing participation showed a total of 1,052 persons and 868 gear units. Areas not normally surveyed totaled 7.8% and 7.4 % of the total person and gear-units, respectively. Only 2 methods (spear with snorkel and spear with scuba) demonstrated less than 85% of the participants and gear-units surveyed on the inshore participation route. Spearfishing with snorkel showed 16.9% participants and 15.5% gear occurred in nonsurveyed areas. Spearfishing with scuba had a higher percent occurring outside the survey area 41.7% participants and 41.7% gear).

Incidental observations during the 48 aerial surveys included counts of 131 sea turtles. The numbers of turtles, broken into regions sighted during FY90 and FY91, are shown in Table 5 and further explained in Hensley (ms, in prep.).

RECOMMENDATION

The initiation of computer stored records in FY82 and the development of the GIES program in FY85 has greatly reduced the amount of time needed to compile and analyze Guam's inshore fisheries survey data. Because of this, more effort continues to be spent to toward quality control and to upgrade our data collection procedures to ensure statistical reliability.

Aerial observations show that, for most methods, 85% of the participants and gear-units are being surveyed on the inshore participation route when compared to the island wide count. Because of the differences seen in the less observed methods (i.e., spearfishing) it is recommended that these surveys be continued.

Since the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. During FY90, the GIES computerized expansion system was evaluated and rewritten. The new expansion and an upgrade in hardware to a Macintosh computer system has enhanced the analytical capabilities during FY91. An effort to systematically analyze past years inshore database that has been initiated should be continued to establish management needs, if indicated. With these analyses, reasons for the shift in fishing effort, ranking of fish species (i.e., changes in gerreids, scarids, lutjanids) and a trend toward declining catch with increased participation, due to reasons other than data collection techniques, should be made clear. Other changes in fishing methods (gill net, spearfishing) should be further analyzed with respect to offshore fishing to determine if any differences are due to increases in boat use for these methods, especially in the southern portion of Guam.

With the implementation of updated length-weight charts for FY92, changes in weights from the new charts should be monitored. Further analysis of size class distribution in catches through past surveys years should be analyzed to determine if observed changes in species ranking and harvest is due to decline in size class of fish caught. Because of problems in interpreting changes in family and species ranking due to number of catch interviews, attempts should be made to investigate and incorporate new analyses of the database (either additional to or replacing the existing method) in order to give a better indicator of variances due to catch and participation counts.

Professional exchanges and training (both on and off-island) should be continued in order to continually improve the inshore methodology and expansion results and interpretations. Results of the project, Studies of Recreational Important Reef Fishes, should be incorporated with this project so management plans can be initiated.

PROJECT COST

The estimated cost of this project was \$81,000.

Report prepared by: Rebecca A. Hensley

Table 1a. Estimated inshore participation, effort, and total harvest (kg) for all methods during the day in FY91.

METHOD	Persons	Gears	Trips	P-Hours	G-Hours	Catch	CPUE
Hook and Line	37,662.6	38,082.9	20,667.2	127,649.7	129,066.0	24,943.0	0.19
Cast Net	7,663.1	6,914.4	5,630.5	18,510.4	16,689.9	10,662.9	0.64
Gill Net	6,225.0	2,932.5	2,626.0	26,482.7	12,486.5	12,693.2	1.02
Surround Net	245.0	42.6	42.6	1,516.5	263.7	775.4	2.94
Spear with Snorkel	1,598.9	1,574.4	993.5	2,917.1	2,894.8	4,695.3	1.62
Spear with SCUBA	37.5	25.0	6.2	187.5	125.0	2.8	0.02
Drag Net	62.2	23.3	23.3	168.1	63.0	195.8	3.11
Finfish Totals	53,494.3	49,595.1	29,989.3	177,432.0	161,588.9	53,968.4	0.33
Hook and Gaff	583.2	646.5	223.4	1,527.7	1,697.9	567.4	0.33
Other	747.4	747.4	281.7	1,789.0	1,789.0	2,498.3	1.40
Nonfinfish total	1,330.6	1,393.9	505.1	3,316.7	3,486.9	3,065.7	0.88
Day Total	54,824.9	50,989.0	30,494.4	180,748.7	165,075.8	57,034.1	0.35

Table 1b. Estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY91.

METHOD	Persons	Gears	Trips	P-Hours	G-Hours	Catch	CPUE
Hook and Line	11,702.6	11,522.0	4,381.7	36,211.1	35,919.5	3,124.5	0.09
Cast Net	115.5	74.0	59.9	258.0	174.3	44.3	0.25
Gill Net	3,207.0	1,435.4	1,397.4	9,509.2	4,221.7	5,295.8	1.25
Surround Net	0.0	0.0	0.0	0.0	0.0	0.0	
Spear with Snorkel	1,233.0	1,179.7	439.5	2,821.6	2,699.9	1,227.7	0.45
Spear with SCUBA	35.0	35.0	11.6	52.5	52.5	0.0	0.00
Drag Net	522.4	71.4	71.4	1,356.9	182.4	612.2	3.36
Finfish Totals	16,815.5	14,317.5	6,361.5	50,209.3	43,250.3	10,304.5	
Hook and Gaff	124.9	110.9	110.9	124.9	110.9	178.4	1.61
Other	1,086.7	1,086.7	577.9	2,979.3	2,979.3	483.8	0.16
Nonfinfish total	1,211.6	1,197.6	688.8	3,104.2	3,090.2	662.2	0.21
Night Totals	18,027.1	15,515.1	7,050.3	53,313.5	46,340.5	10,966.7	0.24

Table 1c. Estimated inshore participation, effort, and total harvest (kg) for all methods during the day and night in FY91.

METHOD	Persons	Gears	Trips	P-Hours	G-Hours	Catch	CPUE
Hook and Line	49,365.2	49,604.9	25,048.9	163,860.8	164,985.5	28,067.5	0.17
Cast Net	7,778.6	6,988.4	5,690.4	18,768.4	16,864.2	10,707.2	0.63
Gill Net	9,432.0	4,367.9	4,023.4	35,991.9	16,708.2	17,989.0	1.08
Surround Net	245.0	42.6	42.6	1,516.5	263.7	775.4	2.94
Spear with Snorkel	2,831.9	2,754.1	1,433.0	5,738.7	5,594.7	5,923.0	1.06
Spear with SCUBA	72.5	60.0	17.8	240.0	177.5	2.8	0.02
Drag Net	522.4	71.4	71.4	1,356.9	182.4	612.2	3.36
FinFish totals	70,309.8	63,912.6	36,350.8	227,641.3	204,839.2	64,272.9	0.31
Hook and Gaff	708.1	757.4	334.3	1,652.6	1,808.8	745.8	0.41
Other	1,834.1	1,834.1	859.6	4,768.3	4,768.3	2,982.1	0.63
Nonfinfish total	2,542.2	2,591.5	1,193.9	6,420.9	6,577.1	3,727.9	0.57
Totals	72,852.0	66,504.1	37,544.7	234,062.2	211,416.3	68,000.8	0.32
Manahac	N/A	N/A	N/A	N/A	N/A	840.9	
Fusiler	N/A	N/A	N/A	N/A	N/A	0.0	
Scads	N/A	N/A	N/A	N/A	N/A	72,627.3	
Seasonal total	N/A	N/A	N/A	N/A	N/A	73,468.2	
Total (FinFish)	70,309.8	63,912.6	36,350.8	227,641.3	204,839.2	137,741.1	0.67
Grand Total (All)	72,852.0	66,504.1	37,544.7	234,062.2	211,416.3	141,469.0	0.67

Table 2. Day catch composition of FY '91 for the top ten species and families harvested.

Species	Harvest (Kg)	%	Family	Harvest (Kg)	%
<i>Selar crumenophthalmus</i>	83,890.8	65.83	Scads*	83,890.8	65.83
<i>Kyphosus cinerascens</i>	6,981.8	5.48	Kyphosidae	7,332.3	5.75
<i>Siganus spinus</i> **	5,457.9	4.28	Acanthuridae	6,354.9	4.99
<i>Caranx melampygus</i>	3,530.5	2.77	Siganidae	6,682.9	5.24
<i>Mulloides flavolineatus</i>	2,751.8	2.16	Carangidae	5,589.5	4.39
<i>Acanthurus triostegus</i>	1,977.4	1.55	Mullidae	4,400.7	3.45
<i>Acanthurus lineatus</i>	1,416.8	1.11	Mugilidae	1,842.2	1.44
<i>Naso lituratus</i>	1,332.7	1.05	Lethrinidae	1,289.5	1.01
<i>Crennigil crenilabris</i>	1,312.3	1.03	Labridae	1,174.4	0.93
<i>Naso unicornis</i>	1,211.8	0.95	Hemiramphidae	1,092.5	0.86
Total day finfish	127,436.6	86.21	Total	127,436.6	93.89

* The scads were separated from the family Carangidae due to differences in harvest method and management significance.

** Manahac (juvenile *Siganus spinus* and/or *S. argenteus*) were not incorporated into species ranking but were included in the family ranking.

Table 3. Night catch composition of FY '91 for the top species and families harvested.

Species	Harvest (Kg)	%	Family	Harvest (Kg)	%
<i>Acanthurus triostegus</i>	756.9	7.34	Acanthuridae	1,809.8	17.56
<i>Mulloides flavolineatus</i>	665.0	6.45	Mullidae	1,458.4	14.15
<i>Selar crumenophthalmus</i>	638.2	6.19	Sphyracnidae	728.3	7.07
<i>Crennigil crenilabris</i>	541.0	5.25	Scaridae	696.6	6.76
<i>Siganus spinus</i>	474.03	4.60	Mugilidae	659.1	6.40
<i>Acanthurus guttatus</i>	430.5	4.18	Scads*	638.2	6.11
<i>Parupeneus barberinoides</i>	419.8	4.07	Siganidae	630.1	5.13
<i>Scarus sordidus</i>	407.0	3.95	Lutjanidae	528.7	4.44
<i>Kyphosus cinerascens</i>	391.4	3.80	Holocentridae	457.8	4.20
<i>Sphyrana barracuda</i>	387.9	3.76	Lethrinidae	424.3	4.12
Total night finfish	10,304.5	49.59	Total	10,304.5	77.93

* The scads were separated from the family Carangidae due to differences in harvest method and management significance.

Table 4. Combined day and night catch composition of FY '91 for the top species and families harvested.

Species	Harvest (Kg)	%	Family	Harvest (Kg)	%
<i>Selar crumenophthalmus</i>	84,529.0	61.37	Scads*	84,529.0	61.37
<i>Kyphosus cinerascens</i>	7,373.2	5.35	Acanthuridae	8,164.7	5.93
<i>Siganus spinus**</i>	5,931.9	4.31	Kyphosidae	7,723.8	5.61
<i>Caranx melampygus</i>	3,869.0	2.81	Siganidae	7,313.1	5.31
<i>Mulloidies flavolineatus</i>	3,416.8	2.48	Carangidae	6,028.1	4.38
<i>Acanthurus triostegus</i>	2,734.4	1.99	Mullidae	5,859.1	4.25
<i>Acanthurus lineatus</i>	2,201.5	1.60	Mugilidae	2,501.3	1.82
<i>Crenmugil crenilabris</i>	1,853.3	1.35	Lethrinidae	1,713.8	1.24
<i>Naso unicornis</i>	1,494.3	1.08	Holocentridae	1,397.1	1.01
<i>Naso lituratus</i>	1,376.2	1.00	Lutjanidae	1,388.5	1.01
Total all finfish	137,741.1	83.34	Total	137,741.1	78.74

* The scads were separated from the family Carangidae due to differences in harvest method and management significance.

** Manahac (juvenile *Siganus spinus* and/or *S. argenteus*) were not incorporated into species ranking but were included in the family ranking.

Table 5. Incidental turtle observations from aerial surveys performed from October 1989 through September FY '91. (The % total for turtles is the % of total observed turtles, n=131. The % total for each of the species categories is the percent for that fiscal year. The 'Others' category includes loggerheads, leatherbacks, olive ridleys as well as unidentified turtles.)

Date	Turtles	Greens	Hawksbills	Others
FY '90	55	43	9	3
% Total	42.0	78.2	16.4	5.4
FY '91	76	36	7	33
% Total	58.0	47.4	9.2	43.4

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: F-1

STUDY NO.: 2

JOB NO.: 1

STUDY 2: Computerized Data Manipulation of Guam's Fisheries Data

JOB TITLE: Data Processing

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

During FY91, offshore and inshore fisheries survey data were entered onto computer files and edited for completeness and accuracy. The offshore database for this fiscal year contains 4,422 records and the "inshore-catch" and "inshore-participation" databases contain 490 and 48 records, respectively. The primary software packages used for data analysis were the Guam Offshore Expansion System (GOES) for the offshore fisheries survey data and the Guam Inshore Expansion System (GIES) for the inshore fisheries survey data. No new data was entered into the database for Job 8, "Studies of Recreationally Important Reef Fish."

BACKGROUND

Guam's Division of Aquatic and Wildlife Resources (DAWR) has been collecting fisheries information over the past 23 years (with only the last fourteen years of data being reliable) and, as a result, an enormous amount of fisheries management data has been accumulated. Computers have been used over the past seven years by DAWR to store and analyze this data. DAWR personnel, working closely with the National Marine Fisheries Service (NMFS), have developed and purchased programs for analyzing the Division's offshore and inshore fisheries survey data.

In FY83, a program entitled the GOES was developed based on the current practices of offshore data analysis and, in FY85, the GIES was completed and tested for errors (this program underwent modifications in FY90 to take advantage of the storage capability and speed of computers that are currently available). Since this time, all data collected for the offshore and inshore fisheries surveys have been analyzed through the use of these two programs.

Study 2 Computerized Data Manipulation of Guam's Fisheries Data, has been jointly funded by the U.S. Fish and Wildlife Service, the NMFS, and the Western Pacific Regional Fisheries Management Council.

OBJECTIVES

1. Computerize the DAWR's offshore and inshore marine fisheries data and transfer the finalized fisheries data files and reports to NMFS personnel in Honolulu, Hawaii for regional application.
2. Provide technical assistance to DAWR staff biologists in the form of efficient statistical analysis and report generation.

PROCEDURES

Guam's offshore fisheries survey data are analyzed by a system of computer programs known as the GOES. This programming package is a 5-step system that summarizes, sorts, and statistically expands the survey data to produce monthly and annual catch, effort, and species composition estimates. Two proportionality constants and a "total participation boat count" are calculated and manually entered into the expansion module by the user. Reports are generated by the GOES that give a breakdown of the estimated offshore harvest by gear type on a monthly and annual basis. Also, an estimated harvest by species is generated for each gear type with a corresponding percentage of the total catch for that gear type.

Guam's inshore fisheries survey data are analyzed by a programming package known as the GIES. The original GIES was a 4-step system that relies on two sets of survey data to determine an annual inshore estimated harvest. This program was modified in FY91 so that DAWR can take advantage of the new computer technology in data storage and processing speed. The two sets of data are referred to as "inshore-participation" and "inshore-catch." "Inshore-participation" data consists of fishermen and gear counts obtained by biological Technicians when driving around the island and making observations on fishing activity within the fringing reef. "Inshore-catch" data are obtained by fishermen-intercept interviews that usually occur within a predetermined survey region. These data consist of a total catch and catch by species for each interview. Because of the apparent differences in participation and catch-per-unit-effort (CPUE) of the various gear types between daytime and nighttime fishing, a fisheries survey is conducted during each of these two time periods and the data are analyzed separately. Also, data are collected during the seasonal harvest of juvenile rabbitfish (*Siganus sp.*) and bigeye scad (*Selar crumenophthalmus*), but, because of the dissimilarities between the seasonal fisheries and the routine inshore fisheries, the two are analyzed separately.

RESULTS

Offshore Fisheries Survey Data Base Management

The DAWR's offshore fisheries survey data for FY91 were entered onto computer files and edited for completeness and accuracy. The total number of records for the FY91 offshore database is 4,422. This brings the total number of historical and current offshore records to 32,914 (this total is the total of all species records, the inshore data is the total number of interviews and can contain many species records). Since the FY91 Guam International Fishing Derby (GIFD) data has not yet been entered onto the database, the total number of fishing derby records remains at 1,986.

Based upon the expansion calculated by the GOES, the estimated island-wide offshore harvest for FY91, including the GIFD results, is about 400 metric tons. For more detailed information, see Job 1, "Offshore Fisheries Survey."

Inshore Fisheries Survey Data Base Management

The FY91 DAWR inshore fisheries survey data were entered onto two databases. The number of records of "inshore-catch" reported for the years prior to FY90 was the number of individual fish measurements. With the new modifications instituted in FY90, the number of records refers to the number of interviews that were conducted. In previous years (prior to FY90) "inshore-participation" referred to each activity in each area; with the new modifications, it is the number of participation survey days conducted during the year. The "inshore-catch" and the "inshore-participation" databases for this fiscal year contain 490 and 48 records, respectively. This brings the total number of historical and current "inshore-catch" records to 4,400 and the "inshore-participation" records to 552.

Based upon the expansion calculated by the GIES, the total FY91 harvest estimate for Guam's inshore fisheries, combining day fishing, night fishing, and seasonal fishing, is approximately 142 metric tons. For more detailed information, see Job 2, "Inshore Fisheries Survey."

Other Fisheries Data Bases

During FY87, a database was established for the storage and dissemination reef fish data used for Study 3, Job 2, "Studies of Recreationally-Important Guam's Fish." This database has been inactive for this fiscal year.

RECOMMENDATION

Data processing has become a valuable asset to the many research projects currently undertaken at DAWR. Data storage and retrieval, data analysis, and report generation has improved greatly since the installation of a computer system. The modifications to the inshore programs have greatly reduced the time required to input and process. It is, therefore, recommended that this office modify the GOES program to run on the new computers that are currently available and to produce user manuals for the new GOES and GIES systems.

Report prepared by: Timothy S. Sherwood

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: FW-2R-28
SUB-PROJECT NO: F-1
STUDY NO.: 3
JOB NO.: 2

STUDY 3: Studies of Guam's Recreationally-Important Fish

JOB TITLE: Biology of *Mulloides flavolineatus*

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Biological sampling conducted during FY85 on the yellowstripe goatfish (*Mulloides flavolineatus*) was analyzed during FY91 and the management needs assessed. Through a variety of sampling techniques 352 specimens were obtained. The biological analysis found a 1:1 sex ratio with females dominating the larger size classes. This species exhibits a seasonal spawning peak in March and spawning did not correlate to any lunar cycle. The population distribution and historical harvest records indicate a 90% decrease in harvest over the last six years and an absence in fish in the larger size classes. Recommendations for management were determined necessary for preservation of a stable stock and primary management suggestions included development of marine preserves and legislation to increase minimum gill net mesh sizes.

Job 3, the Biology of the Emperor Snapper (*Lethrinus harak*) was tabled until FY92 at which time completion of data collections and analysis will be performed.

BACKGROUND

The family Mullidae (goatfish) are commonly found in shallow marine waters of tropical, subtropical and some temperate regions (Thresher, 1979). Fifteen species belonging to three genera are found in Micronesia (Myers 1989). Characteristically, they are elongate and heavy bodied with two well separated dorsal fins, a forked caudal fin and a pair of sensory barbels on the chin (lower jaw) which fold back into special grooves when not in use. They are benthic-browsing carnivores, using the barbels to probe the sand for small soft-bodied invertebrates, fish and crustaceans which comprise their diet. The mullids includes: diurnal, nocturnal, and crepuscular feeders. They feed singly or in small groups over soft sediments of sand or mud.

Sexual dimorphism in goatfish has not been well described. Differences between males and females have been noted for size ranges, shape and dentition but for only a few examples. The differences are not consistent within the family (Munro, 1974; Thresher, 1979). *Mulloides martinicus* females average 1 cm larger than males while *Parupeneus maculatus* males are the larger sex. Male *M. martinicus* males less than 21 cm long tend to be deeper bodied and heavier than females of the same length. Munro (1974) suggests that size differences are related to differential rates of growth and age at sexual maturity. Thresher speculates that larger size is related to differences in sexual selection in modes of spawning. Large female size is associated with group spawners while large male size is related to pair spawners. In all cases there is a broad overlap in size ranges between sexes indicating that the fish are gonochoristic (sexes are fixed and do not change over time).

Goatfish have a characteristically long spawning period punctuated by one or two peaks of activity. Spawning occurs primarily in the spring and summer. In the Caribbean peaks of activity occur in spring (February to May) and fall (September and October) (Munro, 1974). In Hawaii, Moffit (1979), reported the "kumu" *P. ciliatus* is reproductively active most of the year with a peak from December to July. Lunar periodicity has been reported for several species of goatfish. In Palau goatfish spawn on or a few days after the new moon (Johannes, 1981). Lobel (1978) observed *P. multifasciatus* to spawn two days before the full moon. Goatfish are repetitive spawners, which produce pelagic eggs. The larvae remain planktonic for a relatively long period of time, one and a half to two months (Moffit, 1979). Juvenile goatfish settle out of the plankton at 40 to 60 mm and by 90 to 100 mm they have attained full adult proportions and coloration. Growth and maturation to full sexual maturity can occur within one year. Moffit (1979) found that the Hawaiian kumu can reproduce the first breeding season after hatching. An estimate of one year is also given by Thresher (1979) and Hayes (1982) as time to first sexual maturity.

On Guam the goatfish *Mulloides flavolineatus* is an important source of food, sought after by recreational and subsistence fisherman. They are highly desirable both as adults and juveniles. As new recruits to the reef, the very young goatfish (called tiao') are considered a delicacy.

Mulloides flavolineatus are opportunistic browsers, which feed on invertebrates in soft sand and mud. Unlike other mullids however, they show considerable evidence of dietary specialization. Sorden (1983) found *M. flavolineatus*, studied at Midway Islands, to prey primarily on polychaete worms, xanthid crabs and bivalve molluscs. The preferred food was polychaetes.

The major objectives of this study were to determine certain aspects of the natural history and biology of the goatfish *Mulloides flavolineatus*, which could be useful when planning a management strategy. Investigated parameters included: population structure, sex ratio and length frequency distribution, length-weight relationships; age at first maturity, spawning seasonality and fecundity.

METHODS

Fish were sampled during a twelve-month period from October 1984 to September 1985. We attempted to obtain a minimum of 10 fish per week. Fish were collected from a recreational fisherman using a fish weir (a permanent trap which sampled day and night). In addition, Division of Aquatic and Wildlife Resources staff collected at night with spear while snorkeling. These methods were utilized because they provided a representative adult sample where other methods were biased for size. The following variables were documented: length (fork length (FL) to nearest 1 mm), weight (blotted wet weight to nearest 0.1 grams), sex, sexual maturity (reproductive stage of ovaries), ovary weight (to nearest 0.01 grams), fecundity. The sex of immature fish were recorded while those specimens damaged beyond recognition in the process of collection (speared in the gut) and adult fish with the sex unidentified were classified as undetermined. Sex and reproductive state of ovaries were determined by visual (macroscopic) inspection. Reproductive state was qualified as one of the following five categories:

- Stage I: Immature - ovary threadlike and translucent, of uniform width throughout.
- Stage II: Mature developing - ovary expanded, development beginning anteriorly.
- Stage III: Mature unripe - ovary fully expanded.
- Stage IV: Ripe - ovary fully developed, includes "running condition".
- Stage V: Spent - ovary empty, post spawning.

Fecundity was estimated by counting the number of eggs in three sub-samples of Stage IV ovaries, taking an average and calculating the number in the entire ovary based on the ratio of the average weight of the sub-sample to the entire ovary weight.

Size at sexual maturity was defined as the smallest size class at which all female fish were sexually mature. The chi-square test was used to determine whether the sex ratio differed from an expected 1:1 ratio and whether size (in 5 mm FL increments) differed between sexes.

Harvest estimates for FY86 through 91 were obtained from the Division of Aquatic and Wildlife Resources creel survey data base and annual reports.

The cumulative reproductive size class contribution was calculated by using the following 6 steps (column references are to Table 5):

1) Weighted calculation of number of females (Column A): To describe the reproductive population size distribution the monthly samples of females had to be weighted due to the fact that this species reaches maturity within a year of recruitment and also because recruitment pulses are common. The monthly samples were recorded in 5 mm size classes, then these values were converted to a percent of the total monthly sample which was multiplied by the square root of the sample size for that month (Pauly 1984). These new values (weighted number of females per size class) were summed by size class for all months for the total sample period (12 months). Then a simple regression equation was calculated where (X)= the median length in each size class and (Y)= the weighted calculation of the total number of females in each size class. Only the paired data for size classes at which the collection technique was effective and larger were used. This was determined by the size class with the most specimens harvested. The number of individuals in smaller size classes were determined by using the derived regression equation to back calculate these values. Using the derived regression, the number of expected females (Y) with the median value for each size class (X) was recalculated.

2) Calculated number of mature females (Column C): A regression analysis in which X = the median of each size class and Y = the natural log of the number of females ÷ ((the number of females + (0.5 multiplied by the number of immature fish)) was calculated for each size class. The 0.5 value in this equation represents the ratio of females to the number of mature fish. Then recalculate the percent of mature females was recalculated by inserting the median of each size class into the derived regression equation (Column B). Finally, the weighted number of females (column A) was multiplied by the calculated % mature females (Column B).

3) Calculated ovary weight (Column D): A regression analysis was conducted on a spectrum of sample measurements where X = the fork length and Y = the natural log of the ovary weight over a spectrum of size classes. Using the derived equation, the median of each size class X was inserted and a calculated ovary weight Y determined.

4) Calculated number of eggs. (Column E): The average ovary weight of each size class was multiplied by the previously calculated number of eggs per gram .

5) Percent contribution per size class (Column F): The calculated number of eggs for each size class was summed to determine the total number of eggs generated by the population. This total was then divided by the value for each size class and multiplied by 100.

6) Cumulative reproductive contribution (Column G): The values in Column F were summed from smallest to largest recording the cumulative sum in each size class.

RESULTS

Collections

Because of logistic difficulties and unpredictable field conditions the prescribed collection regime was not always met. No collections were made in November. Preliminary collections confirmed the catch methods would adequately sample the size classes, which included adult fish.

Sex Ratio

A total of 352 specimens were collected. Of these, 27 were immature and for sampling reasons the sex of 15 could not be determined, 140 were male and 170 were female. The sex ratio was found to be an expected 1:1 ratio ($X^2 = 2.90$, $p = 0.05$, $df=1$, s).

The length/weight relationship for *M. flavolineatus* was tested separately for males and females using regression analysis, natural log of length vs. natural log of weight. The results were analyzed and tested for equivalence using an ANCOVA (Analysis of Covariance) as described in Sokal and Rohlf (1981). The slope was the same for males and females (2.58908.; $F = 3.$; $df = 1, infinity$, $p = 0.05$; ns). Since the slopes of the regression lines for males and females were not significantly different, length/weight relationship, analysis was conducted on a combined set of data. The regression lines for combined males and females is presented in Figure 1. This test indicates these fish grow morphometrically.

Spawning Seasonality

Spawning seasonality was determined for each month. Spawning activity (Table 1) was based on the percentage of monthly collections in Stages I-V.

Table 1. Reproductive season for *Mulloides flavolineatus*.

Month	STAGES									
	I		II		III		IV		V	
	#	%	#	%	#	%	#	%	#	%
October (84)	33	94.3	0	0	2	5.7	0	0	0	0
December	15	62.5	3	12.5	4	16.7	4.2	4.2	1	4.2
January (85)	7	25.9	11	40.7	6	22.2	7.4	7.4	1	3.7
February	5	15.6	1	3.1	22	68.8	6.3	6.3	2	6.3
March	3	8.1	2	5.4	15	40.5	21.6	21.6	9	24.3
April	2	3.9	14	27.5	25	49	15.7	15.7	2	3.9
May	12	26.7	22	48.9	7	15.6	4.4	4.4	2	4.4
June	10	33.3	16	55.2	2	6.9	0	0	1	3.4
July	5	20.8	17	70.8	1	4.2	4.2	4.2	0	0
August	3	16.7	13	72.2	2	11.1	0	0	0	0
September	1	3	22	66.7	9	27.3	1	3	0	0

Actively reproductive (ripe or spent) fish were found in 9 of the 11 months sampled. No activity was found during October and August. The peak in activity occurs from January through April with the highest concentration in March.

Figure 1. Natural Log Length/Weight Regression Analysis for *Mulloides flavolineatus*.

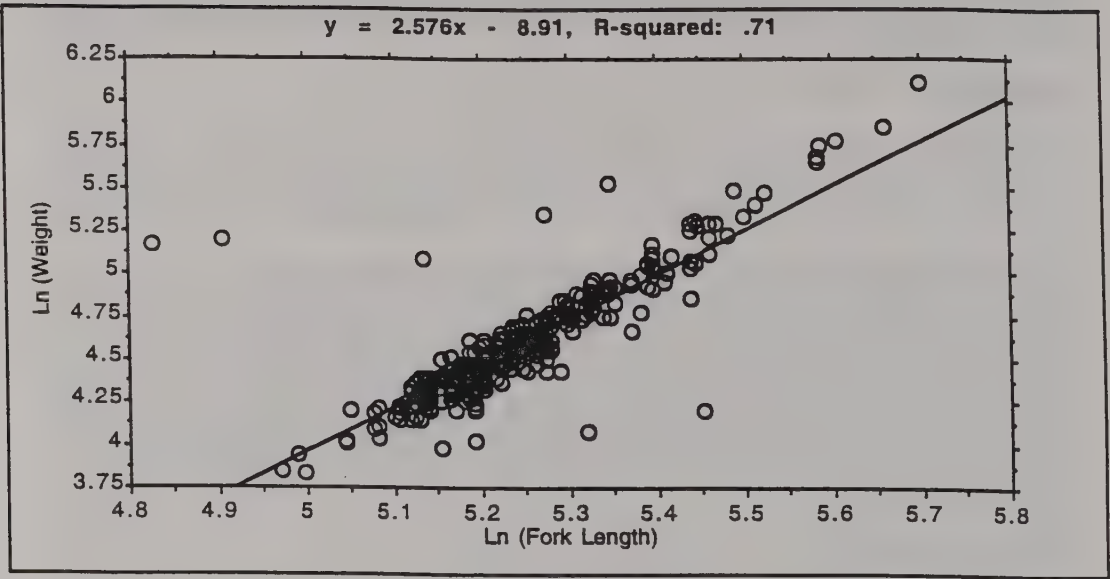


Figure 2. Length/frequency distribution for males, females, immature, and unknown samples in 5 mm size classes. These are raw data values.

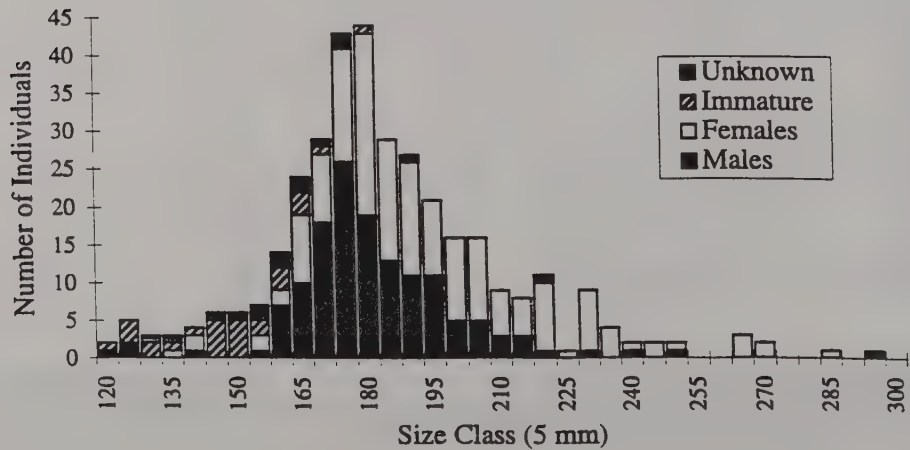


Table 2 presents seasonal spawning data for ripe and spent males and females separately and both sexes combined. Peaks in activity vary between sexes. For males the most ripe individuals appeared in April (19.2%), the most spent in January (9.1%). The most ripe females were found in March (35.3%) and the most spent in March (47.1%). The greatest activity centers around March, April and May for both sexes. For both sexes combined the greatest number of ripe fish were collected in March (20.6%) and the greatest number of spent fish in March (26.5%).

Table 2. Reproductive status of *Mulloidies flavolineatus*. Abbreviations 1-7 include the following: 1 = number (#) collected; 2 = # ripe; 3 = percent (%) ripe; 4 = # spent; 5 = % spent; 6 = total #; and 7 = % monthly total.

Males	MONTHS										
	O	D	J	F	M	A	M	J	J	A	S
1	4.0	0	0	0	25.0	6.0	5.0	19.0	20.0	0	14.0
2	0	0	0	0	3.0	4.0	0	1.0	0	0	0
3	0	0	0	0	12.0	66.6	0	5.3	0	0	0
4	1.0	0	0	0	2.0	1.0	3.0	6.0	8.0	0	0
5	25.0	0	0	0	8.0	16.6	60.0	31.6	40.0	0	0
6	1.0	0	0	0	5.0	5.0	3.0	7.0	8.0	0	0
7	25.0	0	0	0	20.0	83.3	60.0	36.8	40.0	0	0
Females											
1	0	7.0	0	0	9.0	11.0	13.0	14.0	11.0	15.0	10.0
2	0	0	0	0	3.0	2.0	2.0	0	0	0	0
3	0	0	0	0	33.3	18.2	15.4	0	0	0	0
4	0	5.0	0	0	4.0	1.0	8.0	6.0	1.0	0	0
5	0	35.0	0	0	44.4	9.1	61.5	42.9	9.1	0	0
6	0	5.0	0	0	7.0	3.0	10.0	6.0	1.0	0	0
7	0	35.0	0	0	77.7	27.3	76.9	42.9	9.1	0	0
M&F											
1	4.0	7.0	0	0	37.0	17.0	18.0	33.0	31.0	15.0	24.0
2	0	0	0	0	6.0	6.0	2.0	1.0	0	0	0
3	0	0	0	0	16.2	35.3	11.1	3.0	0	0	0
4	0	5.0	0	0	6.0	2.0	11.0	12.0	9.0	0	0
5	0	71.4	0	0	16.2	11.8	61.1	36.4	29.0	0	0
6	1.0	5.0	0	0	12.0	8.0	13.0	13.0	9.0	0	0
7	20.0	71.4	0	0	32.4	47.1	72.2	39.4	29.0	0	0
% Total Collected	0.5	2.7	0	0	6.5	4.3	7.0	7.0	4.8	0	0

Lunar occurrence of spawning activity

In order to determine whether the spawning activity of *M. flavolineatus* coincides with a particular lunar phase the percentages of actively reproductive (ripe and spent) individuals were examined for each lunar phase. The percentages of collections which fell on each quarter moon phase are as follows: new = 20.8 %, first = 29.2%, full = 12.5%, last = 37.5 % (Table 3). Ripe and spent individuals were collected on all moon phases. Of the collections with actively reproductive individuals 12.5% occurred on the new moon, 8.3 % on the 1st quarter, 8.3% on the full moon, 16.7% on the last quarter moon. Ripe individuals were collected on all moon phases. Spent individuals were collected only on the last quarter moon.

Table 3. Ripe and spent collection percentages of individual *Mulloides flavolineatus* for each moon phase. Abbreviations for 1-5 include the following: 1 = number (#) of collections; 2 = percent (%) collected; 3 = % ripe; 4 = % spent; 5 = % ripe and spent.

Moon Phase	New	1st Quarter	Full	Last Quarter
1	5.0	7.0	3.0	9.0
2	20.8	29.2	12.5	37.5
3	60.0	28.6	66.7	44.4
4	0	0	0	33.3
5	0	0	0	33.3

Nine of the 11 months included in the sampling period had collections, which fell on a moon phase (Table 4). Actively reproductive fish were collected in 5 of these months, January through May.

Table 4. Lunar occurrence of spawning activity for ripe and spent *Mulloides flavolineatus*. Moon Phase abbreviations include: N = New; FQ = first quarter; LQ = last quarter; and F = full. Abbreviations for 1-11 include the following: 1 = total number (#) collected; 2 = # males (M); 3 = percent (%) ripe M; 4 = % spent M; 5 = # females (F); 6 = % ripe F; 7 = % spent F; 8 = # M and F; 9 = % ripe M and F; 10 = % spent M and F; and 11 = total % ripe and spent.

MONTH	SPAWNING ACTIVITY											
	PHASE	1	2	3	4	5	6	7	8	9	10	11
October	LQ	10	0	0	0	1	0	0	1	0	0	0
December	FQ	7	0	0	0	0	0	0	0	0	0	0
January	FQ	7	4	50	0	2	0	0	6	33.3	0	33.3
February	FQ	17	7	42.6	0	9	22.2	0	15	33.3	0	33.3
	N	1	0	0	0	1	100	0	1	100	0	100
	FQ	3	1	0	0	2	0	0	3	0	0	0
March	LQ	19	10	100	0	9	55.6	44.4	19	78.9	21.1	100
	LQ	15	6	83	16.7	8	12.5	37.5	15	40	20	66.7
	N	1	1	100	0	0	0	0	1	100	0	100
April	F	8	5	100	0	3	66.7	0	8	87.5	0	87.5
	LQ	10	7	42.9	0	3	66.7	33.3	10	71.4	14.3	85.7
	N	10	4	0	0	6	33.3	0	10	20	0	20
	FQ	7	1	100	0	6	33.3	0	7	42.9	0	42.9
May	LQ	10	1	100	0	9	11.1	0	10	20	0	20
	N	10	3	0	0	7	0	0	0	0	0	0
June	LQ	2	0	0	0	2	0	0	0	0	0	0
	N	5	1	0	0	4	0	0	0	0	0	0
	FQ	3	1	0	0	2	0	0	0	0	0	0
	FQ	1	1	0	0	0	0	0	0	0	0	0
	FQ	4	2	0	0	2	0	0	0	0	0	0
July	LQ	12	6	0	0	6	0	0	0	0	0	0
	LQ	10	4	0	0	6	0	0	0	0	0	0
August	LQ	5	4	0	0	1	0	0	0	0	0	0
	F	4	2	0	0	2	0	0	0	0	0	0

Ripe males were collected during the new moon in March (this collection consisted of a single individual, no other fish were collected on this date), the first quarter moon in January representing 50% of the collection, the full moon in February and April (representing 42.6% and 100% of collections respectively), and the last quarter moon in March and April representing 93.8% and 42.9% of these collections. Spent males were collected on the last quarter moon of March and April representing 16.7% and 33.3% of these collections. Ripe females were collected on the new moon in February and April (100% and 66.7% of collections) (the February collection consisted of one individual), first quarter moon in April (33.3% of the collection), full moon in February (22.2% of the collection), and last quarter moon of March, April and May comprising 35.3%, 66.7% and 11.1% of each collection respectively.

Size Distribution

Specimen lengths ranged from 122 to 299 mm fork length (FL). The largest male collected was 299 mm. Mature males were first collected in the 120 mm size class. The largest female collected was 287 mm FL. Mature females were first collected in the 135 mm size class. The ratio of males to females is significantly skewed toward females in size classes larger than 220 mm. Thirty-seven individuals 220 mm (FL) or larger were collected. Five of these were males and 32 were females. A length/frequency distribution (5 mm intervals) and numbers of fish collected is presented in Figure 2.

For the sample population the modal size class was 180 mm FL. This size class contains the greatest number of individuals per size class and is the first size class which is fully represented in the sample collection. This also reflects that the sample gear became effective at this size. Assuming that the population of *M. flavolineatus* is normally distributed, the smaller size classes should contain the greatest numbers of individuals as would be expected before natural and fishing mortality reduced their numbers. The expected number of female fish in size classes smaller than 180 mm were calculated by using the known size class frequency data for classes 180 mm and larger. To prevent growth-linked sampling (Pauly 1984) the monthly samples were weighted. The concern for a biased sample over an extended time period stems from the fact this species matures within a year of recruitment and it also displays pulse recruitment. These two factors cause problems in collecting monthly samples which are representative of the population as a whole. The following weighted regression equation was used to calculate the number of females per size class: $\text{natural log } Y = (-.027(X) + 6.369)$, where X = the median length in each size class and Y = the weighted calculation of the total number of females in each size class. Because males and females are not equally distributed through the size classes, the analysis had to be conducted on the female data set. This reduces overall sample size by 50% but increases confidence in estimates for the larger size classes since the females represent a significantly higher proportion than males in size classes above 220 mm. The females also regulated the reproductive contribution and therefore are the population numbers, which will be studied. The results of these calculations are presented in Table 5 column C.

Fecundity

The mean number of eggs per gram of ovary weight of 240,632 was determined from the following three sub-sample taken from a single hydrated ovary. This is not a representative sample but will be used for the purposes of this report to demonstrate the expected trends.

Length (mm)	Weight (g)	Gonads (g)	Sample (g)	# Eggs	Eggs/Weight (g)
310.6	267	12.36	.0491	989	249,043
310.6	267	12.36	.0471	903	236,966
310.6	267	12.36	.0448	855	235,888

This is a measure of batch or clutch size and not annual production as *M. flavolineatus* is probably a repetitive spawner, as are most other goatfish (Moffit, unpublished). Repetitive spawning is a common strategy for tropical reef fish (Johannes, 1978).

Reproductive Contribution

The reproductive contribution of each size class is presented in Table 5. The values in Column F are the cumulative contribution of each size class. The values in column E are the percentage of the total reproductive capacity of the population (total number of eggs theoretically produced by the population) produced by each size class individually. Both of these value emphasize the importance size has on reproductive potential and demonstrates the critical status of Guam's stocks.

Table 5. Variables and calculations for determining the size-specific reproductive potential of *Mulloidides flavolineatus*. Abbreviations are included for the following: A = calculated number (#) of females (fem); B = percent (%) mature fem; C = calculated # of mature fem; D = calculated ovary weight (g); E = calculated # of eggs; F = # contributions; and G = cumulative % contribution.

Size Class mm	A	B	C	D	E	F	G
130	16.31	0	0	0	0	0	0
135	14.25	0.622	8.86	0.491	1,047,179	0.229	0.229
140	12.45	0.654	8.14	0.621	1,215,898	0.266	0.494
145	10.88	0.685	7.45	0.785	1,408,523	0.308	0.802
150	9.50	0.717	6.81	0.994	1,628,217	0.356	1.158
155	8.30	0.748	6.21	1.257	1,878,541	0.410	1.568
160	7.25	0.780	5.66	1.590	2,163,509	0.473	2.041
165	6.34	0.811	5.14	2.011	2,487,640	0.544	2.585
170	5.54	0.843	4.67	2.543	2,856,019	0.624	3.209
175	4.84	0.874	4.23	3.217	3,274,367	0.715	3.924
180	4.23	0.906	3.83	4.069	3,749,122	0.819	4.743
185	3.69	1.0	3.69	5.147	4,574,574	1.0	5.743
190	3.23	1.0	3.23	6.511	5,055,686	1.105	6.847
195	2.82	1.0	2.82	8.236	5,587,397	1.221	8.068
200	2.46	1.0	2.46	10.418	6,175,029	1.349	9.417
205	2.15	1.0	2.15	13.177	6,824,462	1.491	10.908
210	1.88	1.0	1.88	16.668	7,542,197	1.648	12.556
215	1.64	1.0	1.64	21.084	8,335,417	1.821	14.378
220	1.44	1.0	1.44	26.669	9,212,060	2.013	16.390
225	1.25	1.0	1.25	33.734	10,180,901	2.224	18.615
230	1.10	1.0	1.10	42.670	11,251,636	2.458	21.073
235	0.96	1.0	0.96	53.974	12,434,981	2.717	23.790
240	0.84	1.0	0.84	68.272	13,742,779	3.003	26.793
245	0.73	1.0	0.73	86.358	15,188,120	3.318	30.111
250	0.64	1.0	0.64	109.235	16,785,468	3.667	33.779
255	0.56	1.0	0.56	138.172	18,550,811	4.053	37.832

260	0.49	1.0	0.49	174.775	20,501,817	4.479	42.311
265	0.43	1.0	0.43	221.075	22,658,012	4.951	47.262
270	0.37	1.0	0.37	279.639	25,040,976	5.471	52.733
275	0.33	1.0	0.33	353.718	27,674,558	6.047	58.780
280	0.28	1.0	0.28	447.421	30,585,117	6.683	65.463
285	0.25	1.0	0.25	565.947	33,801,782	7.385	72.848
290	0.22	1.0	0.22	715.871	37,356,746	8.162	81.010
295	0.19	1.0	0.19	905.512	41,285,589	9.021	90.031
300	0.17	1.0	0.17	1145.389	45,627,633	9.969	100.0
Total					457,682,762	100.0	

Historic Harvest Analysis

Historical inshore catch records for *M. flavolineatus* for FY86-90 reported by the Division of Aquatic and Wildlife Resources (DAWR) are as follows:

Fiscal Year	Total Harvest (kg)	% of FY86
86	33,896	100
87	11,103	33
88	8,811	26
89	11,397	34
90	4,546	13
91	3,417	10

These declines represent a 90% reduction in harvest over the last six years. In addition, the size classes represented in these harvests fail to show fish in the larger size classes. The largest fish are in the 295 mm range but as reported in Myers (1989), this species obtains a fork length of 360 mm. Additional length/frequency creel data (FY81-90) is listed in Table 6, by 20 mm increments.

Table 6. Length/frequency distributions of *Mulloides flavolineatus* FY81-90 creel data. Data was collected by DAWR in 20 mm increments

Size Class mm	FISCAL YEAR										% Total Harvest
	81	82	83	84	85	86	87	88	89	90	
50	0	0.9	3.5	0	0.6	0	0	0	0	0	0.6
70	4.7	1.3	1.7	5.7	1.9	5.1	0	0	3.3	0.8	1.9
90	26.1	3.9	8.7	5.7	7.8	0	5.3	3.1	3.3	5.7	7.2
110	22.2	16.4	8.7	24.5	18.8	16.7	53.2	22.0	10.9	8.9	19.7
130	16.8	35.6	26.9	28.3	28.6	39.7	33.9	47.8	27.2	23.6	32.5
150	15.4	27.0	28.7	18.9	19.5	20.5	7.6	18.9	33.7	25.2	22.8
170	6.5	9.4	17.4	13.2	11.0	3.8	0	6.3	16.3	17.1	9.2
190	5.0	4.3	1.7	1.9	8.4	2.6	0	1.9	4.3	11.4	4.3
210	2.5	1.1	1.7	1.9	2.6	9.0	0	0	1.1	5.7	1.8
220	0.4	0.2	0	0	0.6	0	0	0	0	0.8	0.2
250	0.4	0	0	0	0	0	0	0	0	0.8	0.1
270	0	0	0	0	0	1.3	0	0	0	0	<.01
290	0	0	0.9	0	0	1.3	0	0	0	0	<.01

Harvest methods used to catch *M. flavolineatus* includes: cast net, gill net, surround net, spear with snorkel, and drag net.

DISCUSSION

The objective of this study was to assemble the biological life history information, assess the harvest techniques and impacts, and assess the management needs. The information obtained important to their management can be divided into three categories: physical characteristics, 2) behavioral characteristics, and 3) harvest analysis.

Physical Characteristics

Mulloides flavolineatus demonstrate a 1:1 sex ratio and grows uniformly with respect to males and females. Female abundance dominates the larger size classes, which suggests that females either live longer or grow faster. It is expected that a faster growth rate is more probable due to size class distribution. Males appear to mature at smaller sizes than females. This species matures (defined as the first size class in which all fish are mature) within a year of recruitment and the size of maturity in females occurs within the 135-139 mm range. During spawning the entire ovary is discharged of eggs. They produce demersal eggs, which are fertilized on the reef before settling, hatching and becoming free floating larvae which go to sea a period of time. Fecundity analysis reveals that the largest size classes represent the majority of the population reproductive potential. To demonstrate the degree of this result, if 17% of the reproductive potential were required to be protected to insure the stability of recruitment; 19 size classes starting at the smallest mature female size class (135 -230 mm) would be required. If the two largest size classes encountered in this study (290 and 295 mm) were preserved, the same effect would result.

The behavioral factors important to management are as follows: Monthly percentages of "ripe" or spent individuals supports a spawning seasonality which peaks in March. Analysis did not support any lunar cycles but this could also be a function of a small sample size and irregular sampling. Observation and annual harvest records indicate pulse recruitment peaks in May.

Harvest Analysis

The harvest results appear to exhibit a downward trend in overall harvest which correlates to the absence of females larger than 300 mm in the harvest. These fish represent a major portion of the recruitment potential. The high harvest figures in 1986 coincide with a large recruitment year. The harvests appear to have become reliant on a large number of recruits. This is supported by the fact that harvest tends to focus on the 100-150 mm size classes. This prevents many fish from reaching the larger size classes over 300 mm which severely impacts reproductive potential.

The available information indicates a reduction in abundance and recruitment. Using the above information the following management strategies are discussed.

Seasonal Closures

Because *M. flavolineatus* exhibits seasonal peaks in spawning and recruitment, proposing a closure to this fishery during these peaks seems suitable. Unfortunately, this behavior is one that is targeted by fishermen and such a closure would reduce available harvests significantly and negatively impact a long-standing tradition. Both the adult and new recruits are easily harvested at this time. This would also be an extremely difficult proposal

to enforce if harvest gear common to this fishery were allowed for other fisheries at the proposed closure time (March).

Gear Regulation or Prohibitions

Most of the gear regulations or prohibitions, which would be viable for this species, involve nets.

Gill nets with small mesh sizes 1/4" and up are used for recruiting juveniles. This non-selective gear with such small mesh sizes should be prohibited. This is not a traditional method and contributes many abandoned nets ("throw-away-nets") because of their low cost to purchase. This ultimately means, very few fish must be caught to pay for the net. In addition, these nets become very easily entangled on the reefs beyond repair and therefore, the owner does not make the effort to retrieve the net. In such a case the net continues to catch and kill fish as well as other marine life. Although abandonment is illegal, enforcement is near impossible under existing statutes.

Larger mesh gill nets (1.5 " and greater) also create a harvest selectivity problem but do not pose the abandonment problems because of their increased cost to purchase. Gill netting is viewed by some as a traditional method, but there is no way the nylon style nets currently being used were traditionally available. The use of other materials for gill net locally is highly doubtful. This method is expected to have contributed heavily to the decrease in larger size classes and due to the non-selective harvest impacts must be considered for some restrictive or prohibitive action. A reasonable proposal would be to increase the minimum stretched mesh size to 3 inches, which would allow only the very largest adults to be harvested resulting in many more smaller fish reaching the larger size classes.

Cast Netting is a highly selective and traditional fishery and does not represent a major threat to this species. The traditional use of cast nets to harvest goatfish focuses on the harvest of the juvenile recruits. Because there are many areas to which these fish can recruit which are not fishable by this method, the harvest of a percentage of the recruits is not a problem at its present level.

Surround Netting is a selective and traditional fishery and does not represent a major threat to this species. The traditional application targets the harvest of the adults.

Drag Netting is a non-selective and traditional fishery and does not represent a major threat to this species but does present a threat to the environment and other demersal fauna. Although this method is traditional, a limited number of specific allowable areas should be designated and/or an allowable maximum length of the net specified.

Size Restrictions

The biology of this fish and the status of the stocks makes it difficult to use size restriction for management. Setting size restriction is usually based on insuring that a fish enters the fishery after it becomes mature. This is not possible since fishing is concentrated partially on the recruiting juveniles. It is however an important approach in managing those methods which target adults. The reality of attempting such management is however impractical. Other size restriction proposals have targeted maintaining 20% of the reproductive pool. To accomplish this one of two strategies could be applied: the first would require restricting the harvest of fish less than 230 mm in fork length (See Table 5), which would basically close all fishing on this species; and the second strategy would require using an upper bound of 280 mm, over which all fish caught would have to be released. This would not work for three reasons: first, the majority of the larger fish are

caught with methods which kill the fish; second, it is not easy to convince a fishermen to release a large prize catch; and, third, there are so few fish in these larger size classes that there would not be much value in pursuing their harvest.

Area Closures

The concept of area closures is one that is receiving much support in the coral reef environments (See FW-2R-28, Study 4, Job 1). In this situation an area which is known to contain assemblages of adults and/or is a historical recruitment area could be set aside as a regulated or no-harvest area. If such an area is no longer available, a site with the proper habitat could be identified. The advantage of such a proposal is that it does not require the entire fishery to be closed. In this particular case, there are no fish currently reaching the very largest size classes. This refers to the size classes ranging from 280 mm to 360 mm. Since egg production is a function of size on a logarithmic scale, more than 99% (based on extension of regression formulae) of the potential reproduction is lost by the absence of such fish. Implementing the area closure concept would ensure that the very large individuals, which provide a significant reproductive pool will have refuge and a known recruitment area will be maintained for the future. Such an area overcomes all the obstacles of gear limitations and can be implemented to allow traditions to continue. This method is the single most suitable management strategy available but should be coupled with the other possibilities to maximize the effect.

Environmental Conditions

Tropical coral reefs are delicate environments and depend heavily on clean clear warm water. Guam has been recently experiencing a development boom, which has increased environmental impacts. A recent discovery made at the University of Guam Marine Laboratory by Dr. Robert Richmond was the interference in fertilization of corals by increased sediment loads and hydrocarbons. Since fish reproduce much the same way coral do, the problem is twice as important. Guam's erosion problem has increasingly worsened over the last few years and research can now show that recruitment of coral is being limited or prohibited by water quality problems. The effect on fish has twice the impact since they also will experience limited or prohibited recruitment but in addition will have suffered a loss of habitat due to the impacts on coral. Proposed management measures will only work if the water quality is suitable for reproduction to be successful.

RECOMMENDATIONS

This project has provided valuable information important to the future management of Guam's fishery resources. This project should be continued on other species, which are felt to be important fishery resources which information is required for the management.

Mulloides flavolineatus

This species appears to be in need of management due to decreasing harvest and the absence of fish in the larger size classes, which significantly decrease the reproductive potential of the population. As a result of these factors the following steps should be taken.

1. Establish a number of preserves, which will provide protection to adults and recruiting juveniles.
2. Develop legislation to revise existing statutes to increase the minimum mesh size to 3" and reduce the maximum length for gill nets.

Lethrinus harak

1. Complete analysis of data and reporting during FY92.

General recommendations

1. DAWR should use information contained in this report to work with the Guam Environmental Protection Agency to develop stricter erosion control programs.
2. The recent harvest results for other key species should be analyzed to determine if the same trend exists.

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Report prepared by: Gerald W. Davis

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO: F-1

STUDY NO.: 4

JOB NO.: 1

STUDY 4. Establishment of a Marine Sanctuary

JOB TITLE: Establishing Permanent Marine Conservation Area

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

This project was inactive FY91.

BACKGROUND

In recent years, marine sanctuaries have become an effective tool for managing tropical multi-species fisheries. A sanctuary reserves an area for the protection of marine resources for the enjoyment of non-consumptive recreational users and to provide refuge for breeding stocks, that will replenish the island reefs with juveniles.

The DAWR's database shows that the total harvest for Guam's inshore fishery has decreased by 39% (not including seasonal fisheries) over the past six years (FY84 to FY90). One reason for this decline is the increase in user conflicts. A prime example of this conflict is East Agana Bay. This bay is a popular fishing area for the local residents. Over the past few years, a great deal of animosity has developed between the local fishermen and the jet ski operators that are trying to utilize the same area.

Another major reason for the decrease in harvest is the large amount of pressure that the inshore fisheries are under. The total number of hours that people have been fishing has almost doubled from 161,602 hours in FY84 to 214,405.1 in FY90. Along with this increase, the average catch per hour dropped from 0.55-0.27 kg. in the same period (not including seasonal fisheries), showing that these fisheries are under severe pressure. Many places have used the sanctuary concept as a way of reducing user conflicts and relieving the pressure that is exerted on the recreational fisheries. An example of a successful sanctuary is Hanauma Bay, Hawaii. In the late 60's, Hawaii experienced a large increase in tourism and heavy fishing pressure. As a result, Hawaii designated Hanauma Bay as a marine life conservation district (sanctuary) where consumptive use of marine life is prohibited, including hook and line, spearfishing, and the collecting of any marine organisms. This area also prohibits all boating activity (including boardsailers, motorboats and jet skis). These prohibitions have lowered the user conflict of the area and appear to have increased the fish stocks of the area. Out of all areas compared by Kimmerer and Durbin (1975), Hanauma Bay had the highest fish abundance (2320 fish/1000 m²) and biomass (6718 kg./hectare). This area has become so popular that in 1975 it attracted over 20,000 visitors per month.

Tumon Bay was selected as the area to establish an MCA because it has wide habitat diversity representative of the island's reefs, and is equally accessible to residents as well as visitors. Tumon Bay is also an area that will benefit recreational users as well as the fishermen of Guam. This area has well defined boundaries that will allow easy surveillance and strict enforcement.

OBJECTIVES

To study the establishment of one or more MCA's in order to provide a refuge for recreationally important fish so they may grow, mature, and reproduce to increase stock health and recruitment.

PROCEDURE

This project was inactive for FY91.

RECOMMENDATIONS

Among Guam's most valuable natural resources are its surrounding coral reefs and associated fisheries. This project should become active in again in FY92 with DAWR conducting public hearings on this issue.

LITERATURE CITED

Kimmerer, W. J., W. W. Durbin. 1975. The potential for additional marine conservation districts on Oahu and Hawaii. Sea Grant Technical Report UNIH-SEAGRANT-TR-76-03. University of Hawaii. 108 pp.

Report prepared by Timothy S. Sherwood

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT.: 6

PROJECT TITLE: Marine Fish Habitat Improvement and Aggregating Devices

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Fish Aggregation Devices

Four of the five nun style buoy shaped fish aggregation devices (FADs) deployed during FY90 were lost. Three of the four losses could be attributed to effects of Supertyphoon Russ. The fourth system (Haputo) was submerged due to damage by a vessel or by "walking off an incline" during high seas caused by Supertyphoon Russ. The system lost during FY90 was lost after only 107 days on station (in August) and was attributed to mooring failure. The average time on station for all five systems was about 237 days (or 8 months).

Data on buoy performance and use was continued to be collected in several ways: by conducting fishermen interviews (creel census, random interviews), aerial observations, and fishing near the FADs. To date, the aerial observations are producing the most useful information on FAD use as well as on-site verification.

Redeployment delays were due to modifications made to the systems and deployment sites in order to keep the systems on site for a longer time period. Improvements in the FADs were incorporated after analysis of failure and information obtained during the 1990 South Pacific Commission Conference. Changes in the FADs included new anchors, stainless steel cotter pins for the safety shackles, welded hardware, and larger capacity nylite thimbles. Four new locations were sounded (3 for the east side of Guam and for 1 for the south side of Guam). Permit modifications were requested for the changes in two locations (Hospital Point and Cocos FAD) and for extensions on the actual FAD permit.

Shallow Water Moorings

The popularity of water related activities have caused an increase in damage to the coral reefs due to the setting of anchors. One way that this damage has been reduced in other parts of the world is by the installation of mooring buoys. During FY91, mooring design was further modified and mooring equipment was received. Initial site selection was made this reporting year.

FISH AGGREGATION DEVICES

BACKGROUND

A variety of FAD designs have been used by many countries, but the basic design consists of a floating object (buoy or raft) attached to mooring line and held in place by an anchor system. For centuries early forms of FADs, like cork rafts in Malta and bamboo rafts in Japan and the Philippines, have been used to attract pelagic (open water) fish. Due to the apparent effectiveness of these floating objects in the Pacific region, the National Marine Fisheries Service (NMFS) began a pilot program in 1977 around Hawaii to determine if a FAD would attract, aggregate and hold pelagic fish in the area, ultimately increasing the catch of fisherman. Because of the great success of this program, twenty-three (23) Pacific basin countries, including the Territory of Guam, had deployed over six hundred (600) FADs by 1983.

Early FADs have had very short life spans. From 1977 to 1984, the life of the FADs ranged from several minutes (lost during deployment) to twenty-two (22) months. Most often cited for losses of these systems, in decreasing order of importance, were hardware or mooring line failure, severe storm activity, man bite (propeller or anchor damage), fish bite, unsuitable site selection and other unidentifiable reasons. Considerable improvements have been made to the design and maintenance of the FADs in order to decrease the premature loss of the system.

Construction of the FADs in Guam began in 1979, initially under funding from the Saltonstall-Kennedy Act through the Pacific Tuna Development Foundation, and was later continued as part of D-J/W-B Sport Fish Restoration program. By the end of FY83, the 10 FAD systems deployed had been lost primarily due to problems involving mooring system design and materials. The FADs have proved successful throughout the Pacific, as well as in Guam. Reactivation of the program was seen in FY87. Information provided by the South Pacific Commission (SPC) regarding design improvements on the mooring systems and deployment procedures, have been incorporated to increase the longevity by decreasing premature loss of the FAD system. During FY90, five systems were deployed and one system was lost (Hospital Pt., 107 days on station).

OBJECTIVE

To enhance Guam's heavily utilized nearshore, leeward fishing grounds through establishment of a system of FADs.

PROCEDURE

FAD Design

Mooring System and Design changes

During this fiscal year, mooring systems for 4 FADs were modified and completed. Modifications were made to the FADs to minimize maintenance requirements and increase lifespan. The design of the FAD system used during the FY90 deployments is seen in Figure 1. The lengths of nylon and polypropylene (Table 1) made according to the current, depth and substrate conditions (Boy and Smith; 1984 and 1987) were adjusted according to changes in hardware.

Table 1. FY91 FAD Mooring Lengths (ft). The Ritidian FAD was not redeployed in FY91.

ROPES	FAD Name (#)			
	Haputo (2)	Hosp. Pt. (3)	Facpi (4)	Cocos (5)
NYLON	1,123.0	1,385.0	1,385.0	1,697.0
POLYPROPYLENE	2,227.0	2,565.0	2,565.0	2,453.0
TOTAL	3,350.0	3,950.0	3,950.0	4,150.0

FLAGGED AREAS

2/3 from TOP	2,233.3	2,633.3	2,633.3	2,766.7
1/3 from BOTTOM	1,116.7	1,316.7	1,316.7	1,383.3

NEW FAD LENGTHS

(as of 22 January, 1992)	2,850 ft	3,000 ft	3,000 ft	3,000 ft
NYLON	771.0	852.3	852.3	852.3
POLYPROPYLENE	2,549.0	2,647.7	2,647.7	2,647.7
TOTAL	3,320.0	3,500.0	3,500.0	3,500.0

FLAGGED AREAS

2/3 from TOP	2,213.3	2,333.3	2,333.3	2,333.3
1/3 from BOTTOM	1,106.7	1,166.7	1,166.7	1,166.7

Some of the other changes include the following:

- 1) The purchase of stainless steel cotter pins to replace the poor quality cotter pins used with the anchor shackles.
- 2) The fabrication of 13 1-1/2 ton anchors (using a pyramidal design, figure 2). Problems after the construction of the anchors showed that the anchors were about one-half the planned weight. The FADs will continue to use two anchors during the next redeployment.
- 3) The purchase of an arc welder to weld the shackles (to reduce the chance of loss due to shackle failure).
- 4) The purchase of larger, greater capacity nylite thimbles (because of observed failure during deployment of smaller systems in Belau).

- 5) The wiring of the McDermott navigational light was modified to prevent arcing and the bulb size was increased to increase the light intensity.

Deployment Procedures

Little change was made to the planned deployment procedure and gear setup described in FY90 annual report. Loading of the gear will be with a small crane, contracted with a private company, and should minimize gear placement problems and delays from using the Port Authority's equipment.

FAD Maintenance and Monitoring

Data collection, for FAD position and fishing activity, was continued using several techniques: aerial surveys (currently being used for inshore fishing activity verification), offshore creel surveys, and incidental fishermen interviews. To expand on the effectiveness of the FADs, monthly boat trips were planned for maintenance and monitoring of the FADs. On these trips, DAWR personnel primarily did routine maintenance, if necessary, observed fish in the vicinity of the FAD, did counts if feasible and fished the area for predators.

RESULTS

Site Modifications and New Locations

Two FAD (Hospital Point and Cocos Island) sites were modified to solve site problems and three new locations for future deployments on the east side of Guam, were chosen. Original (permitted) locations are shown in Table 2.

Table 2. The following lists the permitted areas for FADs deployed during FY91.

Site Number	Site Name	Sept. 89 Revised Location	1990 Actual Installed Location
1	Ritidian	13°42'30"N 144°46'30"E	13°43'32"N 144°45'00"E
2	Haputo	13°35'30"N 144°45'30"E	13°35'30"N 144°45'30"E
3	Hospital Point (formerly Camel Rock)	13°31'42"N 144°43'30"E	13°41'42"N 144°43'30"E
4	Facpi	13°20'30"N 144°36'30"E	13°20'30"N 144°36'30"E
5	Cocos Island	13°14'30"N 144°36'30"E	13°14'30"N 144°36'30"E

* Note: at this time the Ritidian Fad will not be immediately redeployed because of the position of the proposed NOAA weather buoy deployment.

Changes included:

- 1) The Ritidian Fad (FAD 1) is not planned to be redeployed immediately because of a NOAA Weather buoy that is to be deployed within 2 miles of the Ritidian location. This should eliminate interference from having buoys in close proximity of each other and allow redirection of funds for that FAD.
- 2) Depth readings and locations were determined for 4 additional sites, three on the eastern side (Table 3) and one southern side of the island.
- 3) Problems encountered with a telecommunications cable caused us to relocate the Hospital Point FAD to the west of the original site (Table 4).
- 4) The Cocos FAD was moved to an area to the south of Cocos Island (Table 4) to enhance fish attracting activity and to minimize the storm generated problems (i.e., currents). The area for redeployment should minimize "walking" for the system. The affects of currents should be less than the original location.

Table 3. The following are new sites planned for the northern and eastern portion of Guam, in 500 fathoms of water, and are not yet permitted.

FAD NUMBER (NAME)	PROPOSED SITES
FAD 6 (Rota Banks)	13°42'36"N 145°1'36"E
FAD 7 (Fadian Pt.)	13°26'6"N 144°55'18"E
FAD 8 (Asiga Pt.)	13°17'48"N 144°51'35"E

Table 4. The following lists the previously permitted sites (1989) with the proposed FY91 site changes for permit modification.

FAD NUMBER	PERMITTED SITES	PROPOSED SITES
FAD 3 (Hospital Point)	13°31'42"N 144°43'30"E	13°32'48"N 144°41'6"E
FAD 5 (Cocos Island)	13°14'30"N 144°36'30"E	13°11'36"N 144°41'54"E

Permits and Modifications

Requests were submitted for a permit extension and for a modification of the FAD Permit. The Permit expires in FY92 and a five year extension was requested. Because of the Hospital Pt. and Cocos Island FAD site changes, a permit modification was also requested. At the end of the FY91, these modifications were still pending.

Redeployments

Delays in redeployment occurred due to modifications in the systems and with redeployment vessel (*Guahan I*) problems. At the end of FY91, the use of the *Guahan I* was pending the Port Authority's acquiring vessel insurance. Site changes for two of the systems were pending approval from Army Corps of Engineers. As soon as the vessel is available, weather conditions are favorable and the permit modifications are approved, the 4 systems will be deployed.

FADs on Station

The 4 FADs on station during FY91: Ritidian (1), Haputo (2), Facpi (4), and Cocos Island (5) were lost during August 13, 1990. The time on station averaged about 8 months (237 days) for the systems that remained as surface FADs (See Table 5). The Table lists reasons for possible reasons for failure of the FADs systems.

Table 5. Length of time FADs were on site in FY91. List of possible reasons are included.
Average time for FADs to stay on site was 237 days (approx. 8 mos.)

	FAD NAME				
	Ritidian	Haputo	Hosp. Pt.	Facpi	Cocos
DEPLOYED	4/23/90	4/23/90	4/18/90	4/30/90	4/30/90
LOST (Estimated)	12/20/90	5/1/91	8/13/90	12/17/90	12/20/90
LONGITIVITY (Days)	241	372*	107	231	234
REASON for LOSS	Storm	Storm or Vessel	Mooring Failure**	Storm	Storm

* Sited in May completely submerged and was still functioning.

** System was lost in high seas after a series of storms passed through the area.

Fishing Activity

Information gathered as part of the offshore creel surveys has not been as informative as it should be once FADs remain on site for a longer period of time. Future problems may be encountered with fishermen participation because of the delay in deployment of the systems. FADs continued to be good producers for yellowfin, skipjack, marlin, and mahimahi from September through their time of loss.

Offshore fishing activity obtained during Aerial surveys show a continued use of a FAD or FAD alley for fishing. Only those fishing vessels fishing around Guam (no offshore banks) were recorded in the one-hour clockwise flight. All attempts were made to only count each boat one time. Of the boats counted during the aerial survey, (n=468), 59.2% were trolling, 9.9% of the boats were bottomfishing, 12.4% were diving (scuba spear fishing or recreational diving) and the remaining 18.5% were classified as other activity (cast net, gill net, jet ski, parasailing, etc.). Through December 1990 with four FADs on site, 61.1% of the trolling vessels were fishing the FAD and/or FAD alley (area between

the FADs) and 38.8% were fishing elsewhere. Of the boats fishing at or around the FADs, 87.8% fished the northern FADs (1, 2) with only 12.2% of the boats fishing the 2 southern FADs (4 and 5). After the loss of all FADs May through September, (n=118), 68% of the trolling activity occurred in the northern portion of Guam and 38.1% occurred in the southern portion. This change is in part due to the opening of the Agat Marina and shows the increased use in the southern area by fishermen. Differences still occur due to the different manner that the southern FADs are fished by local fishermen with most of the fishing being done at dawn, dusk or at night when the aerial survey is not in process.

Other FAD Activity

Most of the fishing being done near the FADs has been trolling. Reports of people jigging, spincasting, drift fishing and night fishing with lights has occurred. One instance of an individual interested in gill netting around the FADs has been noted. Observations for purse-seiners and longliners in and around the FADs (especially Cocos and Ritidian) was continued during FAD trips, aerial surveys, and creel surveys.

Project Status

During FY87-90: see Hensley 1990. During FY91:

- a) Monitored fishing activity through creel and aerial surveys.
- b) Continued monitoring/maintenance program for the FADs to correct any wear and tear on hardware, light systems, etc. in order to decrease chances of system losses.
- c) Began purchasing equipment for replacement FADs and future deployments.
- d) Chose sites for three eastern FADs.
- e) Did depth soundings for new FAD sites.
- f) Submitted permitting changes for modifications and extensions.
- g) The Hospital Point FAD was lost around 13 August, after 118 days on station. Once the systems moved to the east side of the island, initial attempts to recover the FAD were delayed due to weather conditions. The system was recovered and inspected for hardware damage during November.
- h) A permit was submitted for an artificial reef in the Agat area south of Orote, using 2 scuttled Navy Barges. The permit should be finalized and issued in early FY91.
- i) A computer program was developed for calculating mooring lengths and will be presented at the Fifth International Conference for Artificial Habitat Enhancement in Long Beach, California.

RECOMMENDATIONS

Because of the use of the FADs by the local fishermen and their apparent satisfaction with the FADs affectiveness, it is recommended that this project be continued. During the next

fiscal year, it is recommended that four FADs be redeployed. A general site permit should be submitted to the Army Corps of Engineers for the three new FAD locations for the east side of Guam. Upon completion of the purchase and receipt of additional gear, these FADs should be constructed and deployed once the permit is approved. Any FADs lost, should be recovered, if possible, in order to determine reason for loss. The lost FAD(s) should be replaced, as long as the reason for loss is not due to problems with site selection (i.e., current, depth, etc.). Detailed records should continue to be kept to facilitate changes in future FAD systems, where necessary.

The monitoring of fishing activity around Guam, through existing creel surveys, aerial surveys and incidental fishermen interviews should continue in order to better analyze the FAD and non-FAD use, especially for future deployments. Improvements should be made in the sampling regime to compare fishing in FAD and non-FAD areas.

On all future deployments, modifications and changes that were suggested at the South Pacific Commission's 22nd Regional Technical Meeting, 1990, and any other technical meetings should be incorporated in order to extend the lifespan of these systems. Many modifications suggested were incorporated in the design (see FY90 Annual Report). Other options for a deployment vessel should be investigated because of the problems encountered with use and the rising cost of the vessel. Attendance at future FAD meetings should continue in order to better facilitate information transfer and incorporate this information into the FAD program for improvement of these systems.

SHALLOW WATER MOORINGS

BACKGROUND

Many boaters have a favorite spot where they anchor to dive or fish. The DAWR has received many reports of damage to the reef caused by anchors. It has been estimated that over 30% of anchor settings on coral reefs cause damage (Halas 1985). Some boaters place "home-made" moorings to avoid the problem of anchors getting fouled in coral. "Home-made" moorings are constructed with concrete or automobile parts as an anchor and a buoy connected by chain. These moorings are then haphazardly placed in the general area of heavy coral growth. Storm swells move these moorings around and thereby destroy large amounts of coral. In addition to the storm movement, slack in the chain during low tide causes damage in the immediate area of the mooring. Due to the slow growth of corals, it takes years to repair the damage. This damage not only affects the corals in the immediate area but it also decreases available habitat for other marine organisms.

Halas (1985) studied this problem in the Florida Keys and designed a mooring buoy program that prevents excessive anchor damage to the reefs. Halas' mooring design incorporates an 18 inch deep hole that is drilled into the reef. An eyebolt is cemented into this hole and a mooring line is attached to it. The mooring line runs through the center of the buoy and the end of this line is used as a pick up line by the boaters. Halas placed some of the moorings in areas that were not previously utilized. In conjunction with the mooring buoy program, Halas has printed handouts that describe the areas around each mooring. This program has become such a great success that it is now being extended beyond the park boundaries and has been adopted by islands in the Caribbean and Hawaii. The Halas method will be applied in areas with hard substrate. The anchor system proposed for sandy areas will utilize auger type anchors that were originally designed to cork-screw into the ground to secure guy lines from telephone poles.

OBJECTIVES

To establish a shallow water mooring program to minimize coral damage in common boat anchoring areas and to enhance fishing access in areas with anchoring difficulties.

RESULTS

Modifications have been made to the Halas design for use in Guam's waters. In Halas' system, the upper portion of the mooring system consists of a spherical polyethylene plastic filled buoy and a polypropylene pickup line that are attached to a polypropylene line. In Florida, there is not a problem with theft of these buoys partly because of the constant monitoring that occurs within the marine parks. Because of the difficulty of monitoring the mooring systems on Guam, it was decided to change the upper mooring design to impede problems with theft. A Topper buoy system (foam filled tire with a 6 ft. length of 3/8 in. galvanized chain assembly with a galvanized pickup ring attached) will replace the upper portion of the shallow water mooring system. Even though the cost of each mooring will increase, this should make the mooring easier to see and harder to steal.

Tentative sites for placement of these shallow water mooring are Double Reef, Piti, Apra Harbor, Anae Island, Sella Bay, Cetti Bay. Further sites will be selected prior to initiating the permitting process in order to decrease the time required for Government review and permitting procedure.

Project Status

During FY89:

- a) A literature search was conducted for basic knowledge of shallow water mooring systems.
- b) Fourteen (14) trial auger type anchors were donated to DAWR by the Hawaii Sea Grant Program.

During FY90:

- a) Initial mooring sites were selected.
- b) Topper mooring buoys and chain assemblies were purchased for 30 systems.
- c) A time frame for completion of permits and initial installation was developed.

During FY91:

- a) Topper mooring buoys and chain assemblies for 30 systems were received.
- b) Army Corps of Engineers permitting process was begun.
- c) Correspondence with Green Peace was continued for acquisition of underwater hydraulic drill and training for installation of mooring systems (in conjunction with Belau).

RECOMMENDATIONS

1. Obtain permits.
2. Develop installation and maintenance methodologies.
3. Deploy sand bottom mooring systems as soon as permitting procedure allows.
4. Investigate acquisition of underwater hydraulic drill for use in hard substrate with stainless steel eyebolts instead of augers.
5. Purchase additional equipment as necessary.

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- Report prepared by: Rebecca Hensley

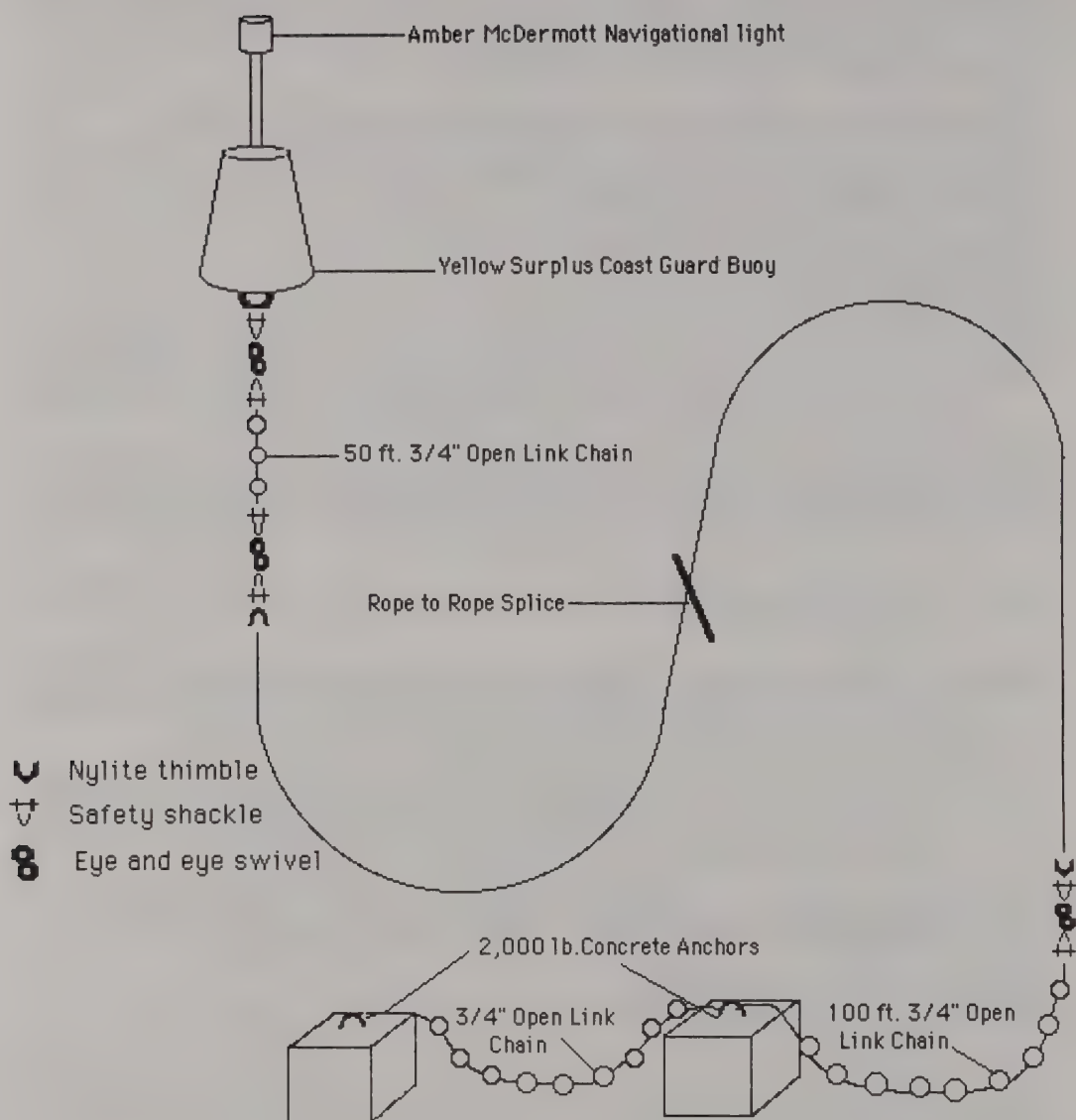
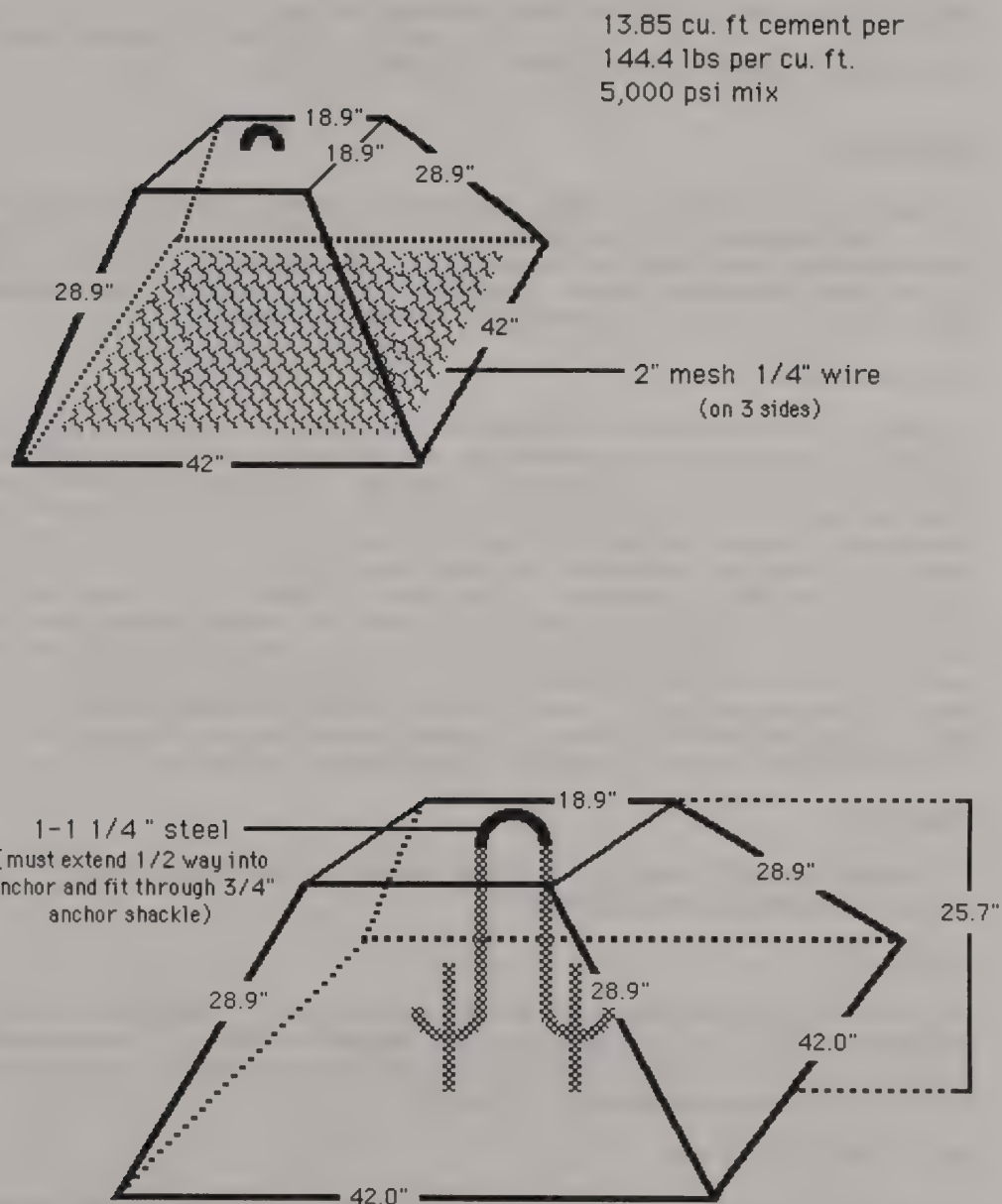


Figure 1. Inverse catenary loop design used in FAD systems deployed during April 1990.

Figure 2. One and one-half ton pyramidal anchors designed for use with FADs.



PROJECT SEGMENT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT.: 7

JOB TITLE: Construction of Small Boat Launching Facilities

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Construction of the Merizo Pier began with a ground breaking ceremony on April 30, 1991. The completion date was projected to be September 28, 1991. However, construction delays have placed the completion date into the first quarter of FY '92. Action on other capital improvement projects is pending review and approval. Recommended projects include boat ramps, navigational buoys, marina improvements.

BACKGROUND

As initially proposed the objective of the Merizo Pier project was to repair and extend the existing pier. An inspection of the existing pier revealed that the structure had deteriorated to the extent that renovation was impractical. The scope of the project was revised to the design and construction of a new pier during FY '88. During FY '89 plans for the construction of a replacement pier in Merizo were finalized and the construction company International Bridge and Construction was retained as of September 26, 1989. A total of \$382,208.80 has been encumbered on this project. During FY '90 plans for the construction of a replacement pier in Merizo were suspended pending clearance from local and federal review agencies which require a site-specific permit before construction can begin. Those agencies are: Government of Guam: Department of Land Management, Bureau of Planning, and the U.S. Army Corps of Engineers. Because the Merizo Pier is located within the Seashore Reserve a clearance permit must be obtained from the Territorial Seashore Protection Commission. These permits were granted.

OBJECTIVE

To increase boating accessibility to fishing grounds through the creation of safe, strategically located boat launching facilities.

RESULTS

Ground breaking for the Merizo Pier was held April 30, 1991. The completion date of September 30, 1991 was not met because of construction delays. Construction has progressed to driving the support pilings, laying the crossbeams and pouring the cement. Projected completion has been extended 2-3 months.

RECOMMENDATIONS

An assessment should be made of the need for development and or enhancement of existing facilities as well as identification of as yet unutilized boating access locations. Enhancement projects might include placement or maintenance of channel markers or

buoys, onshore lighting (floodlights to illuminate access areas), navigational aids and parking lot improvement. Identification of new sites might be facilitated through analysis of demographic distribution of boaters in relation to existing facilities to determine where a need exists for more conveniently located ramps and piers and a review of the reefs and bays of Guam to identify geographic locations with natural features suitable for development as boating facilities.

Report Prepared by: Gretchen R. Grimm

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 2

JOB TITLE: Development of Inshore Fishing Access Facilities

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

During FY91, progress was continued toward completion of a reef fishing platform design, which will increase and/or enhance inshore fishing access. An engineering firm was selected and a contract approved to prepare blueprint and design plans for the platforms. A draft environmental impact assessment was written and submitted for review to the U.S. Fish and Wildlife Service. Their comments have been forwarded to our office for inclusion into our final assessment. Approval to build the fishing platforms at selected sites will be sought through the Government of Guam agencies and the U.S. Army Corps of Engineers. After the permitting process has been completed, the project construction will be submitted for bidding.

BACKGROUND

Historically, reef flat fishing has been a way of life on Guam. Many residents still fish Guam's shallow waters both for food and recreation. Every year, a number of drownings and near drownings take place due to hazards associated with fishing. To provide a safer environment and to both increase and enhance hook and line sportfishing opportunities, reef flat fishing platforms have been proposed for Guam.

Traditionally, local fishermen have constructed platforms in shallow sandy areas. Typically, platforms have been fabricated with "tangan-tangan" poles with a floor of split bamboo lashed to the frame. Frequently, the platforms have two levels to their construction. The first level gets the person fishing off the water to keep dry and provides for a vantage point to view any fish swimming in the area. The second level provides a place for the person fishing to sit and the space below can be used to store fishing equipment not being used. Platform selections are usually near channels or rips to take advantage of fish migrating over the reef to feed during tidal fluxes.

The concept of fishing platforms can be transferred to areas with hard substrata to increase fishing opportunities. Presently, there are favorite inshore and reef fishing areas where people fish because of the shoreline topography or water circulation patterns. Fishing platforms should be located in areas where people cannot fish regularly now due to the existing conditions, in areas that pose a safety problem for people who want to fish, or to make a temporary existing structure more permanent. Fishing platforms built to withstand the natural conditions of the area would allow usage in areas that were typically unsafe.

OBJECTIVE

Plan and design inshore fishing access facilities (reef flat platforms and cliff platforms) on the windward coast of Guam and research the possibilities of alternate sites on the leeward coast.

PROCEDURE

The Division of Aquatic and Wildlife Resources (DAWR) has been actively pursuing the planning, design, site selection, environmental review and construction of the reef flat fishing platforms for three years (Kruckenberg, 1989 & 1990). The primary focus during FY91 was to select an engineering firm and to contract the construction design. A draft of the environmental impact assessment was drawn up following USFWS guidelines and reviewed by the regional office.

RESULTS

An engineering firm has been selected to draw-up the fishing platform plans and has started the process. The company has been contacted on a regular basis to follow-up on the progress. We have received comments back from the USFWS regarding our draft environmental impact assessment and they will be used in preparing the final assessment.

RECOMMENDATIONS

1. This program has valuable traditional fishing application for Guam while providing a safety factor and enhancing fishing opportunities. We therefore recommend that this job continue to develop a fishing platform program for Guam.
2. After the design plans are completed, to select the sites and submit an environmental impact assessment to the US Fish and Wildlife Service, Coastal Zone Management Program, U.S. Army Corps of Engineers and Territorial Seashore Protection Commission for review. To submit the design plans for bidding on construction after permitting has been completed.

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Report prepared by: Wayne L. Kruckenberg

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

JOB TITLE: Non-Finfish Enhancement

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

One hundred broodstock (5 year old) giant clams (*Tridacna derasa*) were obtained from the Micronesian Mariculture Demonstration Center (MMDC), Palau during the last quarter of FY89 and temporarily held at the Guam Aquaculture Training and Development Center (GATDC) at Fadian (herein referred to as the Fadian facility). Eighty-seven of them were placed in unmarked sites within Apra Harbor between Sept. 1989 and January 1990, the remainder having died at the Fadian facility. Twelve clams were placed at each of four Apra Harbor sites, 6 each at 4-5 and 9-10 m depths, respectively. Fifteen additional clams were placed in 10 m of water at the Glass Breakwater site in January 1990. By late February, 1990, most or all of the clams at all the 5 m sites except Sasa Bay and possibly a few of those at the 10 m Glass Breakwater sites had been poached, so those remaining were placed in 10 m. By mid-June 1990, all clams at the Glass Breakwater sites had been poached, leaving only those at the Sasa Bay and Jade Shoals Sites. All clams still extant were measured during January and October 1991 with the exception of those at the deeper Sasa Bay site which could not be located in October due to poor visibility. Positive growth was noted for all except one clam and all but one appeared healthy and free of either parasites or evidence of attempted predation. Growth rates between January and October, 1991 decreased considerably from initial post-release growth rates.

BACKGROUND

Species of giant clams (genus *Tridacna*) are an important traditional food as well as a potentially valuable export commodity for Asian food markets and the worldwide aquarium trade (Copeland and Lucas, 1988). During the past 3 decades, giant clam stocks on most coral reefs have become seriously depleted. Three species are native to Guam: *Tridacna maxima*, *T. squamosa*, and *Hippopus hippopus*. The largest species, *T. gigas* is known from Guam only on the basis of fossils, and apparently went extinct before the arrival of humans. *T. maxima* was once quite common on reef flats as well as clear-water reef slopes, but has become scarce or disappeared on most reef flats. *T. squamosa* and *H. hippopus* are quite rare, and generally occur in less accessible habitats.

All species of *Tridacna* and *Hippopus* are phototrophic, that is they harbor single-celled plants (zooxanthellae) that manufacture most if not all of the clam's nutritional requirements. The clams therefore require relatively shallow, clear water with good exposure to sunlight, but do not require supplemental feeding. When under about 6 to 10 inches valve width, they are prone to predation by certain fishes (primarily rays and large triggerfishes and puffers) and drilling parasitic gastropods. Larger clams and those of reproductive age (5+ years) are relatively immune to predation.

In recent years it has been demonstrated that giant clams may be effectively cultured and transplanted. The species *Tridacna derasa* is the world's second largest bivalve, attaining a

valve length of 60 cm, exceeded only by *T. gigas*. Both these species have proven to be the fastest growing and most feasible of the tridacnid clams to rear in captivity as well as in the wild (Heslinga, et al., 1984; Crawford et al., 1988). *Tridacna derasa* was chosen on the basis of its availability from the nearest hatchery. It is well-adapted to lagoon environments which can be monitored more easily than exposed seaward reefs and has high potential for becoming established as a fishery resource.

OBJECTIVE

To introduce and establish the giant clam *Tridacna derasa* on the reefs of Guam.

PROCEDURES

Procedures for site selection, processing and field placement, and monitoring are given in the FY89 annual report and remain unchanged from that year.

RESULTS

All of the 31 clams remaining in the field were located and measured on January 23, 1991 and all except those at the deeper Sasa Bay site A and one presumed poached were relocated and measured on October 16. Heavy sedimentation and frequent extreme turbidity at the Sasa Bay site A often make it impossible to locate the clams. Since this is the only site in which there has never been evidence of poaching, it is presumed that they are still there. One of the clams at site D was missing without any sign of shell remains in October, so it is presumed poached.

Positive growth was noted for all groups (Table 1). However, growth rates since January decreased considerably from those during the initial release period (0.024 to 0.065 mm/day vs. 0.055 to 0.110 mm/day). Growth rates for the Sasa Bay site A clams was half that of the clams at the other sites prior to January and less than half between January and February (0.024 vs. 0.059 to 0.065). The lowering of growth rates for this species after reaching a shell length of 25 cm is well-documented, and the growth rates observed for at least all sites except A compares quite favorably with growth rates observed elsewhere (Adams, et al., 1988; Crawford, et al. 1988). Possible reasons for the lower growth rates at site A include high turbidity, excessive siltation, or decreased salinity. All the clams at site A except for one with a partially bleached mantle appeared healthy although some had small accumulations of silt on their mantles. There was no obvious evidence of disease or parasites at any of the sites.

Table 1. Growth rates of transplanted *Tridacna derasa*, measured on 10/16/91 in mm per day.

Site/Depth	No. Days in field	No. of Clams	Mean Daily Growth		
			first 472-480 days	last 304 days	776-784 days
A 4 m	784	6	0.055	0.024	0.043
B 9 m*	784	6	0.110	0.065	0.092
C 9 m	776	6	0.105	0.061	0.088
D 9 m	776	5	0.107**	0.059	0.090

* Excludes 2 clams moved from 5 to 10 m during early stages of study.

**Includes 6 clams, 1 of them subsequently presumed poached.

RECOMMENDATIONS

It is recommended that this project remain active as long as transplanted clams are still living. Since over half of the transplanted clams were poached, no new clams should be placed until a more suitable area for seeding is found or a marine preserve with adequate enforcement is established. The clams at the deep Sasa Bay site A should be checked as soon as possible after several days of dry, calm weather. If lower than normal growth rates persist, all the clams at site A should be moved to a new 10 m site near site B. All sites should be photographically mapped to facilitate identification of individual clams so that growth can be tracked individually.

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Report prepared by: Robert F. Myers

GUAM COMMERCIAL FISHERIES

STATE: Territory of Guam

PERIOD COVERED: 1 October, 1990 to 30 September, 1991

JOB TITLE: Commercial Fisheries on Guam

SUMMARY

Progress continued toward transferring the vendor receipt program to monitor commercial fisheries to the Division of Aquatic & Wildlife Resources (DAWR) in FY91. Presently, the vendor data is being processed at the National Marine Fisheries Service (NMFS) in Hawaii. Computer programming at DAWR is nearly complete which will allow the full transfer of the program.

The foreign fleets tranship fresh tuna for the sashimi market in Japan. After fish are graded the reject fish are held in cold storage. Some of these rejected fish are landing in Guam's market which has made competitive local fish sales difficult.

INTRODUCTION

The data collection for commercial fisheries has been on-going since 1980 with NMFS coordinating the collection process. The DAWR continues to receive funding as part of a cooperative agreement with NMFS to assist in monitoring the commercial catch on Guam. We have targeted the major vendors willing to cooperate with us. The goal of our office has been to eventually oversee the commercial fisheries program.

The objective of the commercial fisheries program is to track the offshore fisheries and provide solid economic data for the fishery around Guam. Since the beginning of the program, it has basically covered only the major vendors buying and selling fish, who were willing to volunteer their catch information. We are looking forward to a more aggressive program that will give us a comprehensive overview of the fishery around Guam. It would monitor "all" people who sell and buy fish. If and when this is implemented, it will give us a comprehensive picture of the fisheries activity on Guam.

OBJECTIVES

- 1) To maintain a vendor receipt program for monitoring commercial fisheries
- 2) To provide economic commercial fisheries parameters available for fisheries management purposes

PROCEDURES

DAWR continues to supply receipt books purchased by NMFS to volunteer commercial fish vendors. The Guam commercial fisheries receipt books are supplied on a as-needed-basis to the vendors. Each receipt has space provided for the name of the seller, seller's number, date, number of people fishing, hours fished, fishing location number, fishing method, and catch information along with it's monetary value. There are three copies of each receipt with one for the person selling the catch, one for the vendor, and one for DAWR.

The vendors are visited on a regular basis to monitor their progress, data computation, receipt book completion and to double check the number of remaining receipt books. The receipt books are monitored by using a logbook to indicate when a receipt book is issued to a vendor and returned to the office. The receipt books are then transmitted to the NMFS office in Hawaii for data processing. After the data is input into the computers, the books are returned to DAWR and distributed back to the respective vendors.

RESULTS

During the FY91, DAWR has supplied commercial fisheries receipt books to the major fisheries vendors on Guam. NMFS has input data during FY91 through February at which time data input was transferred to DAWR for the remainder of FY91. In an effort to present all of the data for the fiscal year using the new computer program, the data will be compiled for the upcoming annual report and will backtrack all commercial fisheries data to 1980.

RECOMMENDATIONS

1. The commercial fisheries program should be continued to provide important fisheries and economic data.
2. Work be continued to complete the necessary programming required to fully transfer this program to DAWR.
3. Pursue mandatory reporting under a licensing program to sell or buy fish, which requires use of our commercial fisheries receipts in their business transactions. This would give us a more comprehensive view of the commercial fisheries activity around Guam.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer.

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Population trend data obtained with spotlight counts indicated a significant decrease ($p < 0.05$) in deer numbers at Andersen Air Force Base (AAFB) while Naval Magazine (NAVMAG) recorded no significant decrease. Special either-sex deer hunts were held during in July and August. Sixty tags (20 shotgun and 40 bow tags) were issued for each month. Shotgun hunters made 353 sorties and expended 154.3 hunter days harvesting 15 deer in Northwest Field (NWF). Bow hunters made 317 sorties and expended 137.7 hunter days harvesting 10 deer in AAFB bow areas.

BACKGROUND

The Guam deer (*Cervus unicolor mariannus*) has been under investigation by the Division of Aquatic & Wildlife Resources (DAWR) since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures. The regular deer season is October 1 through December 31 with a bag limit of one antlered deer (buck only) per season per license holder exclusive of any special hunt harvest. The Director of Agriculture can authorize a special either-sex hunt to thin a particular herd in situations where the population poses a threat to life and property and to prevent damage to other natural resources from over grazing.

OBJECTIVES

To determine the current size and distribution of the deer population of Guam and to monitor population trends.

PROCEDURES

1. Continue spotlight counts on AAFB at 21 counts per year, 4 per month in May - July and one per month in other months.
 - a. Record number, age, sex and group composition.
 - b. Statistically analyze count data and compare with past data to discern population trends.
2. Continue monthly spotlight counts on NAVMAG with periodic spotlight counts in other areas.

3. Collect hunting statistics via a hunter questionnaire. Analyze hunting statistics for changes in hunter kill, effort, and hunting location.
4. Collect biological data from carcasses killed during regular season and special hunts or from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

License sales declined 5% during FY91 with 615 sold during the year. Because harvest questionnaires could not be sent out in time to include responses in this report, the results will be included in next year's (FY '92) report.

A record of hunting activity and harvest is kept at Naval Communications Area Master Station and AAFB during the regular season and special hunts (Table 1). According to logs, 144 hunter-days (63.2 hunter-sorties) were expended on the base during the October through December deer season and resulted in the harvest of no deer.

Table 1. Hunter effort and deer take based on official hunter logs from Naval Communication Area Master Station (NAVCAMS), Northwest Field, and bow areas and special hunts on Andersen Air Force Base during FY91.

	Oct	Nov	Dec	Jul	Aug	Sep	Total
NAVCAMS							
No. of hunter sorties							144
No. of hunter days (8hr)							63.2
Deer taken							0
Days effort/take							0
Andersen Air Force Base							
Northwest Field							
No. Hunter Sorties	379	339	445	199	186	196	1744
No. hunter days (8-hr.)	175	150	206	90.6	74.8	79.9	776
Deer taken	9	7	15	11	5	3	50
Days effort/take	19.4	21.4	13.7	8.2	15.0	26.6	101
Bow Areas on Main Base							
No. Hunter Sorties	92	87	62	192	125	52	610
No. hunter days (8-hr.)	40.3	40.8	30.6	82.8	54.5	14.9	264
No. Deer taken	2	2	1	6	4	0	15
Days effort/take	20.1	20.4	30.6	13.8	13.6	0.0	98.5

According to AAFB hunter logs, 776 hunter-days (1744 sorties) were expended at NWF and resulted in the harvest of 50 taken. Bow areas on the main base recorded 264 hunter-days (610 hunter-sorties).

Special either-sex hunts were held at NWF and in bow areas on the main base during the months of July and August, 1991. Sixty tags were issued for each month, 20 shotgun and 40 bows. In NWF, shotgun hunters made 353 sorties and expended 154.3 hunter days, harvesting 15 deer, 11 bucks and 4 does. In AAFB bow areas, bow hunters made 317 sorties and expended 137.3 hunter days, harvesting 10 deer (5 bucks and 5 does).

Spotlight Count Trends

Deer numbers were low on AAFB during FY91 (Table 2). Numbers observed during the best three months of the year for sighting deer, May-July, were significantly different from those observed during FY90 (Mann-Whitney U-Test, $U = 114$, $n_1=13$, $n_2=12$, $p<0.05$, Sokal and Rohlf 1981). The average number of deer seen per count decreased 34% from 132.9 during May-July, 1990 to 87.4 during May-July, 1991. Likewise, numbers observed throughout the entire year varied statistically from those recorded the previous year (Mann-Whitney U-Test, $U = 114$, $n_1=12$, $n_2=12$, $p<0.001$). The average number of deer seen per count (October-September) decreased from 120.5 in FY90 to 86.9 in FY91. The largest single nightly count decreased from 166 (251 deer per 10 km) in FY90 to 132 (200 deer per 10 km) in FY91.

Deer numbers observed on NAVMAG continued to decrease during FY91. However, numbers observed on deer counts were not significantly lower (Mann Whitney U-Test, $U=65$, $n_1=12$, $n_2=10$, $p>0.05$) than those observed the previous year. The average number of deer seen per count decreased from 28.0 deer in FY90 to 25.0 deer in FY91 (Table 3). The largest single nightly count decreased slightly from 38 deer (15.6 deer per 10 km) in FY91 compared to 39 deer (16.2 deer per 10 km) in FY90.

RECOMMENDATION

Continue spotlight counts at present intensity at NAVMAG and AAFB. Collect biological data from carcasses as available.

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Report prepared by: Celestino F. Aguon

Table 2. Composition of deer herd during spotlight counts at AAFB, Guam. (CNT = Count, SD = Standard Deviation, CV = Co-variance)

		1990 1991												Summary Statistics			
	CNT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total	AVE.	SD	CV-%
Un-classed buck	1	7	2	2	2	5	10	6	2	2	19	0	1	75	3.6	4.4	122
	2								1	2	4						
	3								1	0	2						
	4								2	5	0						
	5										0						
Spike	Ave.	7.0	2.0	2.0	2.0	5.0	10.0	6.0	1.5	2.3	5.0	0.0	1.0	66	3.1	2.2	68
	1	4	4	5	1	1	4	2	8	4	3	1	0				
	2								4	1	4						
	3								2	1	2						
	4								3	8	4						
	5										2						
2pt	Ave.	4.0	4.0	5.0	1.0	1.0	4.0	2.0	3.9	3.5	3.0	1.0	0.0	59	2.8	1.9	68
	1	6	1	2	0	3	2	3	3	2	6	7	3				
	2								1	5	3						
	3								2	0	1						
	4								3	2	4						
	5										1						
3pt	Ave.	6.0	1.0	2.0	0.0	3.0	2.0	3.0	2.3	2.3	3.0	7.0	3.0	70	3.3	2.6	78
	1	5	6	2	0	2	1	4	9	2	6	0	1				
	2								4	1	1						
	3								3	3	7						
	4								5	7	1						
	5										1						
4pt	Ave.	5.0	6.0	2.0	0.0	2.0	1.0	4.0	5.3	3.3	3.2	0.0	1.0	25	1.2	1.4	118
	1	1	0	1	2	0	1	0	3	3	1	0	0				
	2								2	0	1						
	3								0	0	2						
	4								3	5	0						
	5										2						
Doe	Ave.	1.0	0.0	1.0	2.0	0.0	1.0	0.0	2.0	2.0	1.2	0.0	0.0	751	35.8	8.9	25
	1	41	46	43	28	42	44	34	30	37	34	35	15				
	2								37	37	30						
	3								37	31	15						
	4								45	48	42						
	5										24						
Yearling	Ave.	41.0	46.0	43.0	28.0	42.0	44.0	34.0	37.3	38.3	29.0	35.0	15.0	192	9.1	5.0	55
	1	3	5	12	5	9	16	5	9	14	12	5	1				
	2								13	15	9						
	3								3	10	8						
	4								5	20	13						
	5										9						
Fawn	Ave.	3.0	5.0	12.0	5.0	9.0	16.0	5.0	7.5	14.8	10.2	5.0	1.0	49	2.3	2.0	84
	1	2	4	0	2	1	3	1	2	0	4	0	2				
	2								1	5	8						
	3								2	0	3						
	4								2	4	3						
	5										2						
Un-classed deer	Ave.	2.0	4.0	0.0	2.0	1.0	3.0	1.0	1.8	2.3	4.0	0.0	2.0	570	27.1	11.9	44
	1	39	36	25	28	17	37	29	24	19	19	26	25				
	2								21	22	16						
	3								66	30	5						
	4								29	33	24						
	5										18						
Total	Ave.	39.0	36.0	25.0	28.0	17.0	37.0	29.0	35.0	26.0	16.4	26.0	25.0	1825	86.9	22.3	26
	1	108	104	92	68	80	118	84	90	83	104	74	48				
	2								84	88	76						
	3								116	75	45						
	4								97	132	59						
	5										57.4						
Miles traveled	Ave.	108.0	104.0	92.0	68.0	80.0	118.0	84.0	96.8	94.5	71.0	74.0	48.0				
	1	4.7	4.8	4.6	4.6	4.6	4.6	4.5	4.2	4.1	4.1	4.8	4.1				
	2								4.2	4.1	4.1						
	3								4.3	4.1	4.1						
	4								4.1	4.1	4.0						
	5										4.1						
Miles (Ave.)		4.7	4.8	4.6	4.6	4.6	4.6	4.5	4.2	4.1	4.1	4.8	4.1				
Km(Ave)		7.5	7.7	7.4	7.4	7.4	7.4	7.2	6.7	6.6	6.5	7.7	6.6				
Deer/10 mi (Ave.)		229.8	216.7	200.0	147.8	173.9	256.5	186.7	230.4	230.5	174.2	154.2	117.1		193.1	41.4	21
Deer/10 km (Ave.)		143.6	135.4	125.0	92.4	108.7	160.3	116.7	144.0	144.1	108.9	96.4	73.2		120.7	25.9	21
Bucks-in-velvet	1	3	3	0	1	0	0	0	0	0	0	0	0	10	0.5	1.0	206
	2								0	0	0						
	3								1	0	0						
	4								2	0	0						
	5										1						
	Ave.	3.0	3.0	0.0	1.0	0.0	0.0	0.0	0.8	0.0	0.2	0.0	0.0				

Table 3. Composition of deer herd during spotlight counts at Naval Magazine, Guam in FY91.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TTL	AVE.	SD	%CV	
Unclassed buck	0	No	data	0	5	1	0	5	0	0	0	0	0	11	1.1	2.08	189
Spike	1			1	1	3	0	0	1	0	1	0	0	8	0.8	0.92	115
2pt	1			2	1	0	0	1	1	0	0	2	8	0.8	0.79	99	
3pt	1			0	0	1	0	0	2	1	1	2	8	0.8	0.79	99	
4pt	1			0	0	0	0	0	0	0	0	0	1				
Doe	12			12	15	8	8	8	3	3	3	8	80	8.0	4.16	52	
Yearling	2			2	4	4	4	8	9	2	1	2	38	3.8	2.70	71	
Fawn	2			0	0	1	0	0	0	1	1	1	6	0.6	0.70	117	
Unclassed deer	12			8	12	15	10	1	3	15	5	9	90	9.0	4.81	53	
Total	32			25	38	33	22	23	19	22	12	24	250	25.0	7.53	30	
Miles traveled	14.4			14.9	15.1	14.2	15	14.2	13.6	14.7	15.1	8.4	139.6	14.0			
Km traveled	23.2			24.0	24.3	22.9	24.1	22.9	21.9	23.7	24.3	13.5	224.7	22.5			
Deer/10 mi	22.2			16.8	25.2	23.2	14.7	16.2	14.0	15.0	7.9	28.6	183.7	18.4	6.23	34	
Deer/10 km	13.8			10.4	15.6	14.4	9.1	10.1	8.7	9.3	4.9	17.8	114.2	11.4	3.87	34	

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: W-1

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam.

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Official logs recording harvest statistics for Andersen Air Force Base (AAFB) indicated Northwest Field (NWF) recorded a hunting effort of 2404 hunter-sorties comprising 1050 hunter-days with a harvest of 216 pigs and an effort/harvest of 4.86 days per pig. Naval Communications Area Master Station (NAVCAMS) documented harvest statistics of 185 hunter-sorties comprising 82.2 hunter days and a harvest of 16 pigs.

BACKGROUND

The wild pig (*Sus scrofa*) has long been an important natural resource on Guam and accounts for the greatest annual hunter recreation and harvest of all game animals. This species has been under investigation by the Division of Aquatic and Wildlife Resources (DAWR) since 1967 and the results of those and more recent studies have been summarized in a Division technical report (Conry 1988). The wild pig on Guam is a descendant of domestic *Sus scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found island-wide but appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam. Pigs occur in high enough densities in many areas that rooting and wallowing damage are common in most forested areas and can be quite severe locally. Depredation on agricultural crops is also a problem, particularly for farmers in southern Guam during the dry season. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers and current hunting regulations provide for a year-round season with bags limits of 2 pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations island-wide and in localized areas.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.
2. Monitor hunter participation and harvest during the legal hunting season.

RESULTS

License sales decreased 5% during FY91 with 615 sold during the year. Because harvest questionnaires could not be sent out in time to include the data in this report, the information will be included in next year's (FY '92) report.

A record of hunting activity and harvest was kept at NAVCAMS and AAFB to monitor hunting activity and harvest (Table 1). Data for NAVCAMS are only for April to September 1991, when the base was reopened for hunting after it was closed during the Middle East crisis. This closure dramatically reduced pig hunting activity on the base during the year.

Table 1. Hunter effort and pigs take based on official hunter logs from Naval Communications Area Master Station (NAVCAMS), Northwest Field, and Andersen Air Force Base during FY91.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
NAVCAMS													
No. hunter sorties						7	0	3	3	10	18	144	185
No. hunter days (8hr)						3.1	0.0	1.2	1.5	6.1	6.5	63.7	82.2
Pigs taken						2	0	3	0	1	5	5	16
Days effort/take						1.6	0.0	0.4	0.0	0.0	1.3	0.0	5.14
Andersen Air Force Base													
Northwest Field													
No. Hunter Sorties	379	339	445	124	111	118	113	75	119	199	163	219	2404
No. hunter days (8-hr.)	175	150	206	48.4	45	49.8	45.3	35.4	49.8	90.6	63.9	90.8	1049.6
Pigs taken	16	16	41	17	19	25	22	11	9	13	12	15	216
Days effort/take	10.9	9.4	5.0	2.8	2.4	2.0	2.1	3.2	5.5	7.0	5.3	6.1	4.8
Bow Areas on Main Base													
No. Hunter Sorties	92	87	62	29	33	72	52	79	46	192	125	52	921
No. hunter days (8-hr.)	40.3	40.8	30.6	12.6	16.6	25.8	28.8	30.6	16.4	82.8	54.5	14.9	394.5
Pigs taken	3	6	7	5	3	12	2	19	9	12	13	6	97
Days effort/take	13.4	6.8	4.4	2.5	5.5	2.1	14.4	1.6	1.8	6.9	4.2	2.5	4.0

Based on hunter logs, NWF recorded 1049.6 hunter-days (2404 hunter-sorties) and resulted in the harvest of 216 pigs (Table 1). Bow areas recorded 394.5 hunter-days (921 hunter-sorties) and resulted in the harvest of 97 pigs. Hunting areas in NWF and on the main base were closed for half of the pig season and was opened until April, 1990. When logs of FY91 were compared to FY90 (DAWR 1990) using only data from April through September, FY90 recorded 330 hunter-days (888 hunter-sorties) and resulted in the harvest of 91 pigs a decrease of 9%. Bow areas recorded 228 hunter-days (546 hunter-sorties) and resulted in the harvest of 61 pigs. This is a large increase over last year when only 9 pigs were taken.

The record of hunting activity from March through September from NAVCAMS indicated that 185 hunter-sorties were expended with a harvest of 16 pigs. This is a 56% decrease from the same period (March through September) in FY90, which recorded 567 hunter-sorties and resulted in the harvest of 36 pigs (DAWR 1990).

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases.

LITERATURE CITED

Conry, P. J. 1988. Ecology of the wild (feral) pig (*Sus scrofa*) on Guam. Tech. Rept. No. 7. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao. 60 pp.

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Report prepared by: Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves.

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

The population of Philippine Turtle-Doves may be on a downward swing as spring game bird surveys conducted this year continue to show a general decreasing trend over last year's count. Stationary counts at Northwest Field (NWF) and the Conventional Weapon Storage Area (CWSA) on Andersen Air Force Base (AAFB) showed significant decreases ($p < 0.05$) in numbers from the previous year. An average of 12.0 doves was recorded per count at NWF, down 59% from FY90. Roadside counts in the CWSA showed a slight decrease with an average of 18.9 doves recorded per count, down 37% from FY90. Turtle-Doves remain distributed throughout most of the island and were observed on 20 of 23 spring game bird surveys conducted during June 1991. The number of doves observed per station increased on four routes, remained the same on four routes, and decreased on 14 routes. This pattern of change was statistically significant ($p < 0.05$). Doves were found in high numbers (≥ 1.0 bird/station) on Cocos Island, CWSA, Y-SengSong, Reserve Craft Beach Road, and Ija.

BACKGROUND

The Philippine Turtle-Dove (*Streptopelia bitorquata*) was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951), and has been regulated as a game bird since as early as 1903 (Conry 1987). Up through the early 1960s, the turtle-dove was very common and found in large numbers in both northern and southern Guam. By the late 1960s, dove populations in southern and central Guam began to decline and have since stabilized at low levels. Populations in northern Guam declined in the late 1970's and early 1980s. Turtle-Doves are now found in appreciable numbers in prime dove habitat on NWF, CWSA and elsewhere on AAFB and at moderate numbers in selected areas of central and southern Guam. A large population still remains on snake-free Cocos Island. Predation by the brown tree snake (*Boiga irregularis*) is the major cause of nest loss (Conry 1988) and this introduced pest is thought to be responsible for the population decline. Because of the decline in numbers and the extremely poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season as of March 28, 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.

PROCEDURES

Call-count and roadside-count surveys were conducted at NWF and CWSA on AAFB. Both surveys were conducted once to twice monthly in early morning. The call-count survey consisted of counting the number and species of doves seen or heard during a 5-minute period at 10 stations in NWF plus the number of doves seen en route between stations. The roadside-count survey at CWSA involved counting the number of doves seen while driving at 25 km per hour along an established 32-km route. The Philippine Turtle-Dove is also included in a twice monthly roadside-count of all birds conducted by DAWR Staff in 3 areas of northern Guam. The results of these surveys are reported in Job W-1-3.

Turtle-Doves were additionally surveyed during spring game bird counts on 23 routes throughout the island in June. These surveys consisted of 5-minute station counts at up to 10 stations per route with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds observed per station.

RESULTS

Population Surveys

Call count surveys and roadside counts were continued at NWF and CWSA on AAFB (Table 1). Surveys on NWF showed a significant decrease over the previous year (Mann Whitney U-Test, $n_1 = 20$, $n_2 = 10$, $U = 183.5$, $p < 0.001$). The average count decreased (59%) from 29.6 birds/survey in FY90 to 12.0 birds/survey in FY91. This is a change from the trend of FY89, which had recorded a significant increase in number of doves since these counts were started in 1983.

Table 1. Results of Philippine Turtle-Dove surveys at Northwest Field (NWF) and the Conventional Weapon Storage Area (CWSA) on Andersen Air Force Base, Guam during FY91.

	NWF			CWSA		
Month	1	2	Average	1	2	Average
1990						
October	21	14	17.5	22	20	21.0
November	15		15.0	29	24	26.5
December			No data			No data
1991						
January	15		15.0			No data
February			No data	16		16.0
March			No data	17	19	18.0
April	28	21	24.0	22		22.0
May	20		20.0	41		41.0
June	20		20.0	23		23.0
July	9		9.0	31		31.0
August			No data	28		28.0
September	23		23.0	12		12.0
Survey Average			29.6			18.9
Standard deviation			13.1			9.7

Similarly, roadside counts in CWSA showed a significant decrease over previous years (Mann Whitney U-Test, $n_1 = 2$, $n_2 = 13$, $U = 232$, $p > 0.001$). The average count per survey decreased (37%) from 30.2 birds/count in FY90 to 18.9 birds/count in FY91. Though the population in CWSA has remained stable since these counts were started in 1983, it appears that the population is on a downward trend.

Spring Game Bird Surveys

Turtle-Doves were recorded on 20 of 23 spring game bird surveys conducted during 1991 (Table 2). Snake-free Cocos Island continues to have the highest count on the island by far, with an average of 5.7 birds observed per station. The Reserve Craft Beach route had the next highest count with 2.5 birds/station. The CWSA, Y-Sengsong, and Ija routes also had station counts ≥ 1.0 bird/station. The largest increase in numbers occurred on Cocos Island survey where the average station count increased 1.3 birds/station. Numbers increased on four routes, remained the same on four routes, and decreased on 14 routes. This pattern of change was significantly different from random variation (Wilcoxon Signed-rank Test, $T = 39$, $p < 0.005$), indicating an island-wide decrease in population levels.

Table 2. Numbers of Philippine Turtle-Doves observed per count and average number of birds per station detected in spring game bird surveys at various locations on Guam in May and June 1991. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Doves Observed	1991 Ave./ station	1990 Ave./ station	Trend in Ave. 91-90
Tarague	9	80.89	1.00	-0.11	
CWSA	10	11	1.10	1.80	-0.70
NWF	10	10.10	2.70	-2.60	
NAVCAMS	10	20.20	1.10	-0.90	
Capitol Improvement Road	10	50.50	0.80	-0.30	
Mt. Santa Rosa	10	60.60	1.40	-0.80	
Y-Sengsong	10	12	1.20	No data	
Two Lovers Point	10	00.00	0.70	-0.70	
Andy South	10	50.50	0.50	0.00	
Navy Golf Course, Barrigada	10	70.70	1.60	-0.90	
Barrigada Hill	9	60.67	0.40	0.27	
Toto Pipeline	8	00.00	0.00	0.00	
Nimitz Hill	10	10.10	0.00	0.10	
Reserve Craft Beach Road	4	10	2.50	3.75	-1.25
Orote Point	6	61.00	1.17	-0.17	
Pulantat	10	00.00	0.40	-0.40	
Cross Island Rd.	10	20.20	0.40	-0.20	
NAVMAG	10	50.50	0.50	0.00	
Umatac	10	40.40	0.40	0.00	
Dandan	10	20.20	0.60	-0.40	
Ija	4	0.80	0.50	0.30	
Merizo	9	10.11	0.88	-0.77	
Cocos Island	10	57	5.70	4.40	1.30

RECOMMENDATIONS

1. Continue call count and roadside count surveys in northern Guam to monitor distribution, relative abundance and population trends of turtle-doves.
2. Keep the turtle-dove hunting season closed until nesting success improves and the population recovers.

LITERATURE CITED

- Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Pub. 3(1):1-359.
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Report prepared by Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam.

PERIOD COVERED: October 1, 1990 to September 30, 1991.

SUMMARY

There was a statistically significant ($p < 0.05$) pattern of change in the data and the differences in survey results between FY90 and FY91 Spring Game Bird counts. Black Francolin occurred on all 10 survey routes in southern Guam and on 6 of 11 northern routes. The Dandan survey route had the highest station counts this year, with an average of 11.9 birds/station. Dandan had the highest relative increase in birds with the average station count increasing 3.1 birds/station. The Dandan, Ija, Umatac, and Merizo routes also had high (> 5.0 birds/station) average counts. Francolin populations are well established throughout southern Guam and appear to continue to expand their range into shrub-grass habitats in central and northern Guam. This species appears able to sustain the current levels of recreational hunting.

BACKGROUND

In 1961, 171 Black Francolin (*Francolinus francolinus*) were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a one-month season in December 1981 with a four bird daily limit and a 20 bird season limit. Francolin populations continued to increase from 1980-1982, but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population consistently increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY '83 to a two-month split season, one month in January, and one month in July, and the bag limit was increased to 5 birds per day with no season limit. Revisions to the francolin season were again made in FY90 extending the season from January 1 to February 28 and from July 1 to August 31. Francolin hunting has increased in popularity and Guam hunters are successfully harvesting birds during the open seasons. Regulations implemented in FY83 remain in effect with hunter participation and adherence to game laws monitored by spot checks by biologists and conservation officers of the Division of Aquatic and Wildlife Resources (DAWR).

OBJECTIVES

To determine current relative abundance and current distribution of Black Francolin on Guam and monitor population trends and hunter harvest.

PROCEDURES

1. Conduct annual island-wide spring game bird surveys (station counts) to monitor distribution and status of francolin throughout the island.

2. Conduct twice weekly station-count surveys during May-June to monitor pre-hunting season status of francolin population in Dandan, Inarajan.
3. Monitor hunter harvest via an annual harvest questionnaire. Collect information on hunter participation, effort, harvest, and areas hunted.

RESULTS

Francolin Hunting Statistics

License sales decreased 5% during FY91, with 615 sold during the year. Because harvest questionnaires could not be sent in time to include responses in this report, the results will be included in next year's report.

Spring Game Bird Surveys

Black Francolin were detected on 15 of 23 spring game bird surveys conducted during May 1991 (Table 1). Francolin were found on 10 of 11 surveys south of Route 4. Though francolin were detected on the Reserve Craft Beach and the Cocos Island surveys in the previous year, none were in this year's survey. Francolin continue to be found at Two Lovers Point. Francolin were found on 6 of 11 routes in northern Guam. The Naval Communications Area Master Station (NAVCAMS) route recorded five birds though none were found the previous year.

Table 1. Numbers of Black Francolin observed per count and average number of birds observed per station as detected in spring game bird surveys at various locations on Guam in May 1991. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Birds Observed	1991 Ave./ station	1990 Ave./ station	Trend in Average 91-90
Tarague	9	0	0.00	0.00	0.00
CWA	10	0	0.00	0.00	0.00
NWF	10	0	0.00	0.00	0.00
NAVCAMS	10	0	0.50	0.10	0.50
Capitol Improvement Road	10	0	0.00	0.00	0.00
Mt. Santa Rosa	10	0	0.00	0.00	0.00
Y SengSong	10	0	0.00	No data	
Two Lovers Point	10	41	4.10	1.40	2.70
Andy South	10	1	0.10	0.00	0.10
Navy Golf Course, Barrigada	10	49	4.90	3.20	1.70
Barrigada Hill	9	42	4.67	2.50	2.17
Toto Pipeline	10	1	0.10	0.00	0.10
Nimitz Hill	10	108	10.80	4.50	6.30
Reserve Craft Beach Road	4	0	0.00	1.25	-1.25
Orote Point	6	18	3.00	3.33	-0.33
Pulantat	10	32	3.20	8.40	-5.20
Cross Island Rd.	10	25	2.50	6.10	-3.60
NAVMAG	10	37	3.70	3.70	0.00
Umatac	10	112	11.20	8.20	3.00
Dandan	10	119	11.90	8.80	3.10
Ija	4	19	4.75	6.50	-1.75
Merizo	9	19	8.44	9.25	-0.81
Cocos Island	10	0	0.00	0.10	-0.10

The Dandan survey route continued to have the highest counts this year with an average of 11.9 birds/station, which was the same as last year. In addition, Dandan had the highest

relative increase in birds with the average station count increasing 3.1 birds/station. The Dandan, Ija, Merizo, and Umatac routes also had high (> 5.0 birds/station) counts. The average number of birds detected per station increased on 9 survey routes and decreased on 7 between 1990 (DAWR 1990) and 1991. There was a significant (Wilcoxon Signed-rank Test, $Z = -0.57$, $p < 0.05$) pattern of change in the data and the differences in survey results between last year. Francolin populations remain well established and stable throughout southern Guam and continue to expand their range into shrub-grass habitats in central and northern Guam.

RECOMMENDATIONS

1. Continue to monitor francolin population status, distribution, and hunter harvest.
2. Increase the response rate of annual hunter questionnaire.

LITERATURE CITED

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Report prepared by Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: FW-2R-28
SUB-PROJECT NO.: W-3
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: The Status and Ecology of Wild Asiatic Water Buffalo on Guam

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

The abundance of wild (feral) Asiatic water buffalo (*Bubalus bubalis*) on Naval Magazine showed a non-significant decrease during FY91.

BACKGROUND

Asiatic water buffalo, known locally as carabao, were introduced to Guam in the 1600s for use as beasts of burden. Some of the island's domestic animals were reportedly let loose during World War II, resulting in the formation of a feral population in south-central Guam in the vicinity of the U.S. Naval Magazine (Anderson 1980). Research on feral water buffalo on Naval Magazine began in about 1966 when the Division of Aquatic and Wildlife Resources (DAWR) began to conduct spotlight counts of buffalo in conjunction with Philippine deer (*Cervus mariannus*) censuses. The size of Naval Magazine's buffalo herd remained fairly constant between 1966 and 1978, averaging about 0.6-0.8 animals/km traveled during counts (Anderson 1980). The population began to increase in 1979 and peaked in 1982, when a mean of 2.6 animals/km traveled was recorded (DAWR 1980-1982). Buffalo abundance declined thereafter, with counts remaining fairly constant at means of about 1.5-1.7 animals/km traveled from 1986-1988 (DAWR 1983-1988). In 1987, Biosystems Analysis Inc. (1989) estimated the buffalo population on the base to contain 75-150 animals. Numbers on DAWR spotlight counts increased to an average of 2.5 animals/km traveled in 1989 (DAWR 1989), but declined to 1.8 animals/km traveled in 1990 (DAWR 1990). Illegal hunting appears to be the major cause of mortality in the population (Conry 1988). High buffalo densities have resulted in localized habitat damage on Naval Magazine (Conry 1988, Biosystems Analysis Inc. 1989).

OBJECTIVES

To monitor the status of the wild Asiatic water buffalo population on Guam and to determine if control measures are necessary to maintain the population at a level compatible with the available resources.

PROCEDURES

1. Conduct monthly spotlight counts on Naval Magazine. Analyze count data and compare with past data to estimate population trends.

RESULTS

The average number of water buffalo seen per spotlight count on Naval Magazine exhibited an almost significant decrease from 1.8 animals/km traveled in FY90 to 1.4 animals/km traveled in FY91 (Mann-Whitney *U*-Test, $U=83$, $0.10>P>0.05$) (Table 1). The mean

number of animals seen per count in FY91 was 29.7 animals. The largest number of water buffalo recorded on a monthly count declined from 71 animals in FY90 to 48 animals in FY91. This is the second consecutive year for which census data suggest a decline in the population.

Table 1. Results of monthly spotlight counts of feral water buffalo at Naval Magazine, FY91.

Month	No. animals observed	Km traveled	Animals/ km	Miles traveled	Animals/ mile
Oct	37	23.2	1.6	14.4	2.6
Nov	no data				
Dec	no data				
Jan	25	24.0	1.0	14.9	1.7
Feb	29	24.3	1.2	15.1	1.9
Mar	38	22.9	1.7	14.2	2.7
Apr	48	24.1	2.0	15.0	3.2
May	35	22.9	1.5	14.2	2.5
Jun	20	21.9	0.9	13.6	1.5
Jul	8	23.7	0.3	14.7	0.5
Aug	27	24.3	1.1	15.1	1.8
Sep	30	13.5	2.2	8.4	3.6
Total	297	224.8	-	139.6	-
Ave	29.7	22.5	1.4	14.0	2.2
SD	10.95		0.56		0.91
CV(%)	37.0		41.8		41.7

No additional work to assess the population parameters of the Naval Magazine herd was done during the year because of manpower limitations.

RECOMMENDATIONS

Continue monthly spotlight counts of water buffalo at Naval Magazine. Additional aerial and ground surveys should be made as conducted in FY '89 (DAWR 1989). An investigation into the impacts of water buffalo on Naval Magazine's vegetation should be initiated. The construction of an enclosure on the base would help to evaluate damage to plant communities caused by browsing and wallowing. Other study activities should be expanded to obtain more biological information on diet, population characteristics, movements and general distribution, and causes of mortality.

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- Biosystems Analysis, Inc. 1989. Natural resources survey for the U. S. Naval Magazine, Guam (NavMag). Naval Facilities Engineering Command, Pearl Harbor, Hawaii.
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Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUBPROJECT NO.: W-4

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Survey and Inventory of Non-Game Birds

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Roadside count data continues to document the decline of Guam's native forest birds. Introduced birds showed some increase in the North and North-Central roadside counts. Northwest Field (NWF) and the Conventional Weapons Storage Area (CWSA) on Andersen Air Force Base (AAFB) remain the center of distribution for Mariana Crows (*Corvus kubaryi*). An inventory of important wetlands on Guam was compiled for publication during the year. Results of seabird counts on Cocos Island suggested for colonies of 1,600-2,000 Black Noddies (*Anous minutus*) and 300-400 White Terns (*Gygis alba*) were present. Guam's Island Swiftlet (*Aerodramus vanikorensis*) population is estimated at about 490 birds. A survey of crows in July produced a population estimate of about 50 birds. Typhoon Russ, which struck Guam in December, caused considerable damage to the forests of southern Guam and some mortality in wildlife.

BACKGROUND

Since the early 1960s, census data have documented the decline in range and numbers of native birds on Guam. Roadside counts initiated in 1960 on four routes in southern, central, and northern Guam by the Guam Division of Aquatic and Wildlife Resources (DAWR) have provided an index to the decline (DAWR 1974-1990). From 1979 to 1981, population trends were monitored using variable circular-plot techniques (Reynolds et al. 1980) and station counts in central and northern Guam (DAWR 1980-1982). In 1981, an intensive forest bird survey was conducted by the U.S. Fish and Wildlife Service and DAWR (Engbring and Ramsey 1984). Some of the transects used in 1981 were repeated in recent years by the DAWR (1982-1988). In 1987, surveys of the Island Swiftlet were begun at the major remaining nest cave on Naval Magazine (NAVMAG). Predation by brown tree snakes (*Boiga irregularis*) is the major factor contributing to the decline of Guam's native bird populations (Conry 1988; Savidge 1986, 1987).

Current distributions of native land birds are as follows: Mariana Crow, restricted to northern Guam with the center of distribution being NWF, Munitions Storage Area (MSA), and adjacent cliffines on AAFB; Island Swiftlet, primarily NAVMAG and the Talofofo River Valley; Common Moorhen, found in wetlands in central and southern Guam; Micronesian Starling (*Aplonis opacus guami*), found on Cocos Island, AAFB, downtown Agana, and the southern coasts of Guam; and the Yellow Bittern (*Ixobrychus sinensis*), found throughout the island (DAWR 1988-1990).

OBJECTIVES

To continue status surveys and natural history studies as called for in the Recovery Plans for Guam's various endangered native birds.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam by DAWR Conservation Officers. These routes were driven at approximately 6-9 km per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.
2. Counts of Island Swiftlets were conducted at Mahlac and Fachi Caves on NAVMAG. Observers sat at the entrances of the caves for a period of 2-2.5 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the caves was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. Prior to each count, observers entered the cave for 0.5-1 hour to look for evidence of nesting and reproductive activity. The presence of nestlings and their calls, and the incidence of adult birds that appeared to be incubating eggs or brooding young, were noted. In order to avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by lifting a mirror up to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen from nests overhead.
3. Recorded-call playback surveys for Mariana Crows were conducted in northern Guam. At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period during which the observer listened for crows. The numbers, distance, and plumage condition of the crows observed were recorded.

RESULTS

Roadside counts on the North, North-Central and NWF routes (Figure 1) continued to document the status of native forest birds. Data collected during monthly counts in FY91 (Tables 1, 3, and 5) were compared with data from the previous six years for each roadside count route (Tables 2, 4, and 6). Table 7 is a summary of the entire year's data for all three routes.

On the North roadside count, seven species were counted as compared to nine species in FY90 (Table 1). The Mariana Crow was the only native forest observed on this route in FY91. Black Francolins (*Francolinus francolinus*) was observed for the second consecutive year on this route. Black Drongos (*Dicrurus macrocercus*) continued to decline (Table 2), while Eurasian Tree-Sparrows (*Passer montanus*) continued to show an increase begun in FY87. Philippine Turtle-Dove (*Streptopelia bitorquata*) numbers declined by more than half as compared to FY90.

Six species were observed on the North-Central count in FY91 (Table 3). A summary of the data for the last seven years found only one native bird, the Yellow Bittern, to be present on this route (Table 4). Black Francolins were again recorded on this survey in FY91. Eurasian Tree-Sparrows continued to increase in numbers along this route in FY91.

On the NWF roadside count (Tables 5 and 6), two native birds, the Mariana Crow and Yellow Bittern, were observed during FY91. Both showed a decrease in numbers (Table 6). Table 6 documents the decline of Philippine Turtle-Doves, Eurasian Tree-Sparrows, and Black Drongos during the past six years.



Figure 1. Map of Guam showing the locations of roadside counts and the two known Island Swiftlet caves.

Table 1. Average number of birds observed each month on the North roadside count in FY90 and the average number of birds per 100 km.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Tot	No/ Count	No/ 100 km
Yellow Bittern	1	0	0	0	0	0	0	1	0	0	1	0	3	0.13	0.3
Black Francolin	0	1	0	0	0	3	0	0	0	1	0	0	5	0.21	0.3
Lesser Golden Plover	77	41	24	42	39	52	31	0	0	1	8	7	322	13.42	34.9
Philippine Turtle-Dove	1	1	1	3	0	1	4	3	7	6	4	2	33	1.38	3.3
Black Drongo	6	1	3	8	4	2	1	11	16	9	4	2	67	2.79	7.3
Mariana Crow	0	0	0	0	1	0	0	0	0	0	2	0	3	0.13	0.3
Eurasian Tree-Sparrow	7	29	3	3	53	9	0	17	11	17	4	2	155	6.46	16.3
Km	117	66.5	41.8	82.7	77.1	77.1	83.7	76.9	75.6	109	77.4	37	922		
Miles	72.8	41.3	26.0	51.4	47.9	47.9	52	47.8	47	67.7	48.1	23	573		
Counts	3	2	1	2	2	2	2	2	2	3	2	1	24		

Table 2. Average number of birds per 100 km observed each fiscal year on the North roadside count between 1984 and 1991.

Species	FY84	FY85	FY86	FY87	FY88	FY89	FY90	FY'91
Yellow Bittern	4.2	2.3	2.06	2.41	1.95	0.45	0.83	0.33
Black Francolin						0.89		0.54
Lesser Golden Plover	66	49.1	65.12	54.06	55.67	71.21	55.29	34.9
Common Fairy-Tern		0.5		0.36			0.24	
Philippine Turtle-Dove	9.9	6.3	8.13	9.27	10.19	8.13	3.32	3.58
White-throated Ground-Dove			0.2					
Micronesian Kingfisher		0.1						
Black Drongo	23.7	12.2	13.22	10.35	9.85	7.23	3.55	7.27
Mariana Crow	0.3	0.4	0.1			0.23	0.71	0.33
Micronesian Starling			0.88			0.11		
Micronesian Honeyeater		0.1						
Eurasian Tree-Sparrow	6.6	5	8.91	7.59	9.85	13.45	15.16	16.81
Chestnut Mannikin						0.45		

Table 3. Average number of birds per 100 km observed each month on the North-Central roadside count during FY91.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	No./ Count	No./ 100 km
Yellow Bittern	2	0	0	7	0	17	4	2	0	1	5	0	38	1.06	7.32
Black Francolin	0	0	0	0	0	0	6	3	3	7	0	3	22	0.61	4.24
Lesser Golden Plover	166	112	78	198	125	161	59	0	0	4	0	69	972	27.00	187.6
Philippine Turtle-Dove	10	0	1	2	1	5	14	8	10	4	8	1	64	1.78	12.32
Black Drongo	13	6	4	7	6	6	2	5	14	4	5	7	79	2.19	15.21
Micronesian Starling	0	0	28	0	0	0	0	0	0	0	0	0	28	0.78	5.39
Eurasian Tree-Sparrow	116	66	0	19	12	7	16	7	14	36	8	0	301	8.36	57.96
Km	56.3	41.0	41.2	40.2	41.8	41.8	40.9	39.6	37.3	61.8	38.6	38.6	519.3		
Miles	35	25.5	25.6	25	26	26	25.4	24.6	23.2	38.4	24	24	322.7		
Counts	3	2	1	2	2	2	2	2	2	3	2	2	25		

Table 4. Average number of birds per 100 km observed each fiscal year on the North-Central roadside count between 1984 and 1991.

Species	FY84	FY85	FY86	FY87	FY88	FY89	FY90	FY'91
Yellow Bittern	6.7	2.4	3.22	5.04	3.1	2.27	5.11	7.21
Black Francolin					9.75	11.98		4.24
Lesser-Golden Plover	362.69	240.8	483.27	437.92	397.4	289.72	284.79	187.16
Common Fairy-Tern	1.8	1.8		1.53		0.21	2.00	
Philippine Turtle-Dove	34.9	39	37.89	37.26	35.89	24.78	11.78	12.32
Mariana Fruit-Dove	0.2							
Micronesian Kingfisher	1.1							
Black Drongo	44.38	30.9	25.57	22.14	26.14	24.57	18.90	15.21
Mariana Crow	2		0.76	0.88				5.39
Rufous Fantail	0.4							
Micronesian Starling	1.3	1.3						
Micronesian Honeyeater	0.4							
Eurasian Tree-Sparrow	13.9	22.9	36.75	13.59	17.5	7.64	25.34	57.96
Chestnut Mannikin	1.3	0.8		3.29	1.77	2.27		

Table 5. The number of birds observed each month on the Northwest Field roadside counts during FY91 and the number of birds per 100 km .

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total	No./ Count	No./ 100 km
Yellow Bittern									1				1	0.05	0.24
Blue-Breasted Quail				9									9	0.43	2.17
Lesser Golden Plover	105	60	15		148	39			6		11	21	405	19.29	97.69
Common Fairy-Tern				76									76	3.62	18.33
Philippine Turtle-Dove	16	10			8	4	6	2	21	7	22	15	111	5.29	26.77
Black Drongo	24	17	7	21	11	13	8	7	14	21	25	13	181	8.62	43.66
Mariana Crow		1						2	7			1	11	0.52	2.65
Km	54.1	41.8	15.4	31.2	34.3	36	17.2	18.3	58.7	34.9	37	35.4	414.6		
Miles	33.6	26	9.6	19.4	21.3	22.4	10.7	11.4	36.5	21.7	23	22	257.6		
Counts	3	2	1	2	2	2	1	1	3	2	2	0	21		

Table 6. Average number of birds per 100 km observed each fiscal year on the Northwest Field roadside count between 1984 and 1990.

Species	FY84	FY85	FY86	FY87	FY88	FY89	FY90	FY91
Yellow Bittern	9.90	3.70	11.62	4.69	2.72	4.73	2.99	0.24
Blue-Breasted Quail								2.17
Guam Rail	0.30	0.30	0.22					
Lesser-Golden Plover	51.60	17.40	88.26	101.66	114.91	149.99	97.85	97.69
Common Fairy-Tern	0.70	1.40	0.89					18.33
Philippine Turtle-Dove	175.23	159.90	123.11	81.11	60.88	41.79	41.04	26.77
White-throated Ground-Dove	1.70	0.60	2.68					
Mariana Fruit-Dove	2.70	0.60						
Micronesian Kingfisher	9.50	4.60	1.12	0.45	0.25			
Black Drongo	439.10	369.00	282.64	115.96	71.82	54.48	53.00	43.66
Mariana Crow	32.50	28.60	19.44	13.85	10.90	13.68	10.33	2.65
Rufous Fantail	2.70							
Micronesian Starling	20.40	6.00	2.01					
Micronesian Honeyeater	8.90							
Eurasian Tree-Sparrow	8.20	0.30	5.36	2.46		1.49	0.82	
Chestnut Mannikin	2.00	0.90	1.34				0.54	

Table 7. Results of Northwest Field, North, and North-Central roadside counts showing the mean number of birds per 100 km of travel, the standard deviation (SD), and the coefficient of variation (CV).

Species	Northwest Field			North			North Central		
	No/100 Km	SD	CV	No/100 Km	SD	CV	No/100 Km	SD	CV
Yellow Bittern	0.24	0.17	69.1	0.33	0.28	87.3	7.32	3.06	41.8
Black Francolin	0.00	0.00	0.00	0.54	0.54	100.1	4.24	1.29	30.5
Lesser Golden Plover	97.69	24.38	25.0	34.92	12.30	35.2	187.16	36.67	19.6
Philippine Turtle-Dove	26.77	4.85	18.1	3.58	1.46	40.8	12.32	2.62	21.3
Black Drongo	43.66	4.33	9.9	7.27	3.09	42.5	15.21	2.62	17.2
Mariana Crow	2.65	1.21	45.8	0.33	0.37	113.2	0.00	0.00	0.00
Micronesian Starling	0.24	0.17	69.1	0.00	0.00	0.00	5.39	4.67	86.6
Eurasian Tree-Sparrow	0.00	0.00	0.00	16.81	8.74	52.0	57.96	16.15	27.9

Mariana Common Moorhens - Limitations in manpower prevented any major fieldwork from taking place on moorhen studies during FY91. Two censuses of Fena Lake were conducted during the year, with only three birds seen during a rainy morning on 15 November and 15 birds counted on 3 May. Nesting was documented at three new sites on Guam during the year. An empty nest was discovered at Assupian Marsh on 20 August and another empty nest was found in *Eleocharis ochrostachys* at the smaller eastern site of the Pulantat Marshes on 13 September. Two nests, one with 6 eggs and the other empty,

were observed on an aquatic bed of *Hydrilla verticillata* in the open river channel below the Fena Lake spillway on 15 July. No water was flowing down the spillway at the time, thus the site resembled a marsh with a quiet pool of open water. The nests were first seen after a minor chlorine leak occurred at the spillway. On the following day, five eggs from the active nest had been removed, with two seen submerged in the water only 30-60 cm from the nest. Removal of the eggs may have been associated with human intrusion during the monitoring of the spill. It is not known if the remaining egg was successfully hatched by the parents.

The major wetland activity during the year was the compilation of an inventory of important wetlands on Guam, which will be published in the *Oceania Wetland Inventory* by the International Union for the Conservation of Nature and Natural Resources (IUCN). Nineteen sites were described in the report, with ecological and conservation information summarized for each. Major criteria for selecting the wetlands listed in the report were size, uniqueness of the site, and the presence of moorhens, particularly locations where nesting is known to occur regularly. Data for each site were obtained by literature review and field checks.

Inventory sites range in size from the Talofof River Valley (279 ha) to the Barrigada Ponding Basin (0.3 ha). Most of the areas contain a combination of marsh and swamp habitats. Eight have estuarine zones, including four with mangroves. Moorhens are known from 15 of the wetlands and probably occur at two others. Ten sites are artificial. Nearly half (nine) suffer from various types of pollution, the most serious of which has been contamination from oil spills and hazardous wastes.

Seabirds and Reef-Herons at Cocos Island - Data on the status of other bird species on Cocos Island were also gathered after Typhoon Russ (see Appendix A). Two evening counts for seabirds were made on 23 January and 29 August. During both counts, separate observers sat near the southern end of the island, with one watching the east shore and the other facing the west, counting all birds arriving at and departing from the island for 1.67 to 2 hours prior to darkness. Five early morning counts were also made from about 6-9 a.m., but the results of these were inconsistent and much lower than for evening censuses, and were not used for evaluation of population sizes. Seabird counts have not been previously performed on Cocos Island. Census results prove that the island has high conservation value for seabirds. It is vital that appropriate measures be taken to maintain seabird populations there. This will be best accomplished by keeping the island snake-free and limiting development in the forested southwestern half of the island.

Black Noddies - The finding of a large colony of Black Noddies on the island was a surprising event, but probably resulted from past misidentification of the birds as Brown Noddies. Noddies had been previously noted in fairly large numbers on irregular trips to the island during the last several years. Evening censuses provided population estimates of about 1,500-1,800 birds in January and 1,600-2,000 birds in August (Table 8). This is the largest colony of Black Noddies known for any island in the Marianas south of Guguan (see Reichel 1991). However, there is no evidence that the colony is breeding.

Daytime counts of roosting birds revealed that the colony roosted only in *Casuarina* trees in strand forest on the southwestern half of the island, where human disturbance and resort development is minimal. Approximately 50-70% of the colony roosted on resort property. The colony appeared to survive the typhoon in relatively good condition. DAWR staff found the carcasses of 20 birds in storm debris under roosting trees and estimated that 100-200 birds were killed. Additional information on the colony appears in Wiles et al. (in prep.).

Table 8. Results of evening counts by time period for Black Noddies and White Terns on Cocos Island in 1991.

Time Period	Net Number of Birds Arriving			
	23 January		29 August	
	Black Noddies	White Terns	Black Noddies	White Terns
roosting at start	100-200	10	0	12
1700-1710	-	-	5	5
1710-1720	-	-	11	5
1720-1730	90	3	22	4
1730-1740	78	19	27	3
1740-1750	136	28	26	5
1750-1800	146	64	72	3
1800-1810	206	72	142	7
1810-1820	187	55	175	2
1820-1830	268	37	154	5
1830-1840	111	15	277	3
1840-1850	48	1	290	0
1850-1900	51	0	333	0
1900-1910	8	0	35	0
Total	1,429-1,529	304	1,569	54

White Terns - About 300 White Terns were counted on Cocos Island during the census in January (Table 8). From this, the total population was estimated to contain about 300-400 birds. Typhoon-related mortality was judged to be low. No carcasses were found during our searches, but one resort employee did find a dead tern the morning after the storm. The census in August indicated that a much smaller number of white terns were on the island, but this contrasted with the daytime observations of counters, who judged the birds to be no less common than in January. It seems likely that the low August count reflected a different activity pattern among the birds.

Pacific Reef-Herons - Cocos Island continues to be the only location on Guam where reef-herons are known to nest. Up to four adult birds (three dark, one white) at a time were observed on the island in January and August. Two nests in *Casuarina* trees were found near the abandoned Coast Guard station on 29 August and held two nearly full-grown chicks (one dark, one mottled white). Habitat parameters for each nest were recorded in September after the chicks had fledged. On 26 September, an adult was seen regurgitating food to a begging dark-phased juvenile. In the process, the adult dropped a whole fish to the ground, which was collected and later identified as a juvenile Bluefin Trevally (*Caranx melampygus*; fork length = 78 mm).

Other Species - Single pairs of Sooty Terns were flushed from trees on several mornings in January. Six to 10 birds flew to the island during the evening census in January, and a single bird was recorded on the census in August. These are the first records of Sooty Terns roosting on Guam or Cocos Island for many years. A pair of Brown Boobies was seen flying along the reef margin east of the island at dusk on 23 January and may have roosted on Cocos that night. A Great Frigatebird was seen flying low over the island on the morning of 15 January.

Native Doves - Incidental records of Mariana Fruit-Doves (*Ptilinopus roseicapila*) were made again in FY91. Two birds were recorded in the CWSA on November 8, 1990. One individual was seen in a *Neisosperma oppositifolia* and the other was heard calling. These records may represent recolonization attempts by birds from Rota only 60 km north of Guam. The tendency of fruit-doves to cross large bodies of water is unknown. However,

Philippine Turtle-Doves are known to fly between Guam and Rota (Conry 1987). No records of White-throated Ground-Doves were made this year.

Island Swiftlets - Limitations in manpower resulted in only five censuses of Island Swiftlets being made at Mahlac (Firebreak 4) Cave during FY91. Monthly counts from January to April provided consistent population estimates of 380-400 birds (Table 9). A count of 442 birds in July suggested the population grew by as much as 10% from April to June. The timing of this increase coincides well with a major fledging period noted in previous years (DAWR 1987-1989). Limited data on breeding activity collected in FY91 (Table 9) showed that large numbers of young were present from February to April. The passage of Typhoon Russ on 20-21 December had little noticeable effect on the population of the cave (see Appendix A). There was no evidence of a gradual decline in numbers or reproductive activity that might have been caused by reduced insect abundance after the storm.

Low to moderate numbers of snake tracks were noted on the surface of guano deposits on the floor of Mahlac Cave during three visits. No tracks were recorded on two visits. Two snakes were captured on a tall rock face approximately 30-40 m south of the cave's south entrance. The sizes of these animals were as follows: 1) MJM 2639, female, SVL = 737 mm, wt = 42.4 gr; 2) MJM 2847, female, SVL = 821 mm, wt = 71.8 gr. The stomach contents of the snakes have not yet been examined.

Table 9. Results of censuses for Island Swiftlets at Mahlac and Fachi Caves on Naval Magazine during FY91. Evidence of reproductive activities of swiftlets is also presented.

Date	Reproductive Parameters							
	Net No. of Birds Entering Cave	No. of Birds Estimated in Cave at Start of Count	Total No. of Birds Counted	No. of Whole Eggs Found on Cave Floor	No. of Eggshell Fragments on Cave Floor	No. of Nestlings Heard	No. of Nestlings Seen	Incubation or Brooding Observed
Mahlac Cave								
25 Sept 1990	395	22	417	0*	8*	2	2	undetermined
2 Jan 1991	346	37	383	1*	15*	3-4	3	yes
6 Feb	364	30	394	1	15	2-3	6-7	undetermined
5 Mar	351	40	391	5	18	2-3	3-5	undetermined
2 April	333	65	398	0	17	2-3	7	yes
1 July	395	47	442	6*	32*	-	-	undetermined
Fachi Cave								
4 April 1991	17	35	52	0*	0*	2-3	0	undetermined

Key: *note that more than one month had occurred between visits; - = no data gathered.

Five visits to Fachi Cave were made in FY91, but only one census was conducted. Flooding had closed off both entrances of the cave on 19 September 1990 (DAWR 1990), but an inspection on 17 October revealed that the openings were no longer blocked and that birds were entering the cave. Flooding apparently closed the cave again for a short length of time after Typhoon Russ, as determined on 26 December, when the water level was about 60 cm below the top of the east entrance and was already slowly falling (see Appendix A). This sort of sudden flooding during severe storms could possibly trap birds inside the cave at night or result in the loss of all nestlings and eggs. A follow-up visit was not made until 4 April, when the colony was found to have reestablished itself, with 52 birds counted and many nests in use. Count results were nearly identical to those of 14 June 1990 (DAWR 1990). Heavy rains occurred in August 1991, but the cave was still

open on 6 September. However, continued rainfall caused it to become flooded and closed yet again by the time of the next visit on 4 October.

Mariana Crows - A total of 14 transects with 211 stations were used to survey 9 regions in northern Guam as delineated by Engbring and Ramsey (1984) (Figure 2). The Uruno area was not surveyed in 1991 although it was surveyed the previous year. Crows were recorded on 8 transects (or 57%) during the survey (Table 10).



Figure 2. Regions of northern Guam as delineated by Engbring and Ramsey (1984) and adopted in this survey for comparison purposes.

A total of 41 crows were recorded during the surveys (Tables 10, 11). Roadside surveys in the center of the crow population continue to have the most crows. The NWF-Ritidian area recorded the most birds (19), which was a 39% decline over last year (Table 12; DAWR 1990). The Conventional Weapons Storage Area (CWSA) recorded 14 crows, a 61% decline over last year's numbers. Other areas recorded fewer than 3 birds, representing as much as a 100% decline in the number of crows.

Table 10. Summary of results from tape play back of crow calls conducted during July 1991. See Figure 2 for the locations of the transects. Incidental number of crows is the number of crows observed while traversing between stations.

Transect No.	Number of Stations	Number of Crows Obs.	No. of Stations with Crows	No. of Crows Obs. Incident.
1	50	14	12	0
2	36	9	5	0
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	2	1	2
7	10	2	2	0
8	23	0	0	0
9	9	1	1	6
10	9	1	1	0
11	7	2	1	0
12	9	0	0	0
13	8	10	3	2
14	9	0	4	0
15	0	0	0	0

Table 11. Summary of 1991 playback surveys for Mariana Crows according to regional areas.

Regional Areas	Transects Included	Total No. Stations	Total No. Crows	Stations w/Crows	No./ Count	Species Frequency	Species Incidence
Andersen	7,10	18	1	1	0.06	0.06	1.00
Tarague Basin	11,14	8	10	3	1.25	0.38	3.33
Tarague Plateau	4,9	18	4	2	0.22	0.11	2.00
CWSA	1	12	0	0	0.00	0.00	0.00
Pajon Basin	6	23	0	0	0.00	0.00	0.00
Pajon Plateau	3	8	0	0	0.00	0.00	0.00
NWF-Ritidian	2,5,8,13	29	3	3	0.10	0.10	1.00
Urano Basin	15	0	0	0	0.00	0.00	0.00
Mt. Santa Rosa	12	9	0	4	0.00	0.44	0.00

Table 12. Comparison of results between 1990 and 1991 of playback surveys for Mariana Crows.

Regional Areas	No. Stations		No. Crows		Stations w/Crows		Mean/Count	
	1990	1991	1990	1991	1990	1991	1990	1991
Andersen	19	19	23	3	9	3	1.21	0.16
Tarague Basin	15	16	10	2	6	5	0.67	0.13
Tarague Plateau	19	19	1	1	1	1	0.05	0.05
CWSA	50	50	36	14	18	12	0.72	0.28
Pajon Basin	11	11	1	2	1	1	0.09	0.18
Pajon Plateau	12	12	5	0	3	0	0.42	0.00
NWF-Ritidian	75	75	31	19	14	8	0.41	0.25
Urano Basin	11	0	0	0	0	0	0.00	0.00
Mt. Santa Rosa	9	9	0	0	0	0	0.00	0.00

When the number of crows recorded from the surveys is compared to the estimates made by Engbring and Ramsey (1984), all regions have undergone a dramatic reduction in the number of birds. The NWF-Ritidian and Magazine areas, which recorded the highest number of birds, has undergone a 69% and 74% reduction in the numbers, respectively. The Tarague Basin and Tarague Plateau have declined 93% and 95%, respectively.

Micronesian Starlings - A limited investigation of the starling population on Cocos Island was conducted after Typhoon Russ (see Appendix A). Additional data will be summarized and published separately as a journal article at a later date. Twenty-four starlings were captured, measured, color-banded, and released in January and February. Morphological measurements taken from the birds are given in Table 13. It should be noted that the recorded weights are probably lower than normal and reflect the near-starvation conditions under which the birds were surviving after the storm.

Table 13. Measurements of adult and juvenile Micronesian Starlings captured on Cocos Island in January and February 1991 after Typhoon Russ. Measurements appear as means and ranges. One of the juveniles was in poor condition and died after capture.

Age	No.	Wing (mm)	Tail (mm)	Tarsus (mm)	Culmen (mm)	Weight (g)
Adults	23	128.3 121-135	82.7 78.4-88.4	30.7 29.2-33.0	22.9 21.4-24.5	89.8 72-105
Juveniles	2	120.5 120-121	58.2 53.4-63.0	29.5 29.2-29.9	22.0 21.7-22.4	70.0 65-75

Lovebirds at Tumon Bay - Two free-ranging populations of lovebirds were discovered in Tumon Bay during 1990 and 1991. On 18 and 25 September 1990, DAWR staff observed 3-4 Peach-faced Lovebirds (*Agapornis roseicollis*) at Ipao Beach Park. A pair of birds was seen carrying nest material into the rooftop of a park pavillion (number F-1) on both days. In about May 1991, a flock of 6-8 birds was noted ranging from the grounds of the old Pacific Islands Club Hotel west to the edge of the Hilton Hotel property, with most activity continuing to center around Ipao Park. The flock contained one bird that belonged to a second unidentified species or that was a hybrid. The birds reportedly escaped from the Pacific Islands Club Hotel (S. Reidy, pers. comm. to R. Beck).

In September 1991, a population of 18-20 Fischer's Lovebirds (*Agapornis fischeri*) was found residing in central Tumon Bay in the area from the Tropicana Hotel southwest to the Sea Horse Restaurant (R. Beck, pers. obs.). The population appeared to be comprised of three separate subgroups, each with 5-6 birds. Breeding has not yet been verified, but may be occurring. The birds were seen in coconut trees and flying into a small grove of scrubby secondary forest.

Because of the establishment of these populations, which may become permanent, the Guam Department of Agriculture placed a ban on the import of all lovebirds into Guam in September.

RECOMMENDATIONS

1. Continue bi-monthly roadside counts on the three routes in northern Guam.
2. Continue censuses of Mariana Crows in order to estimate population size and distribution.
3. Continue breeding biology studies and attempts to snake proof nest sites of the Mariana Crow.
4. Continue monthly cave censuses and efforts to assess population change and reproductive activity of Island Swiftlets.
5. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofofo River valley about the use of pesticides on their farms.
6. Develop and implement methods for control of the brown tree snake.
7. Continue the captive breeding of endemic endangered native birds on Guam and at stateside zoos.
8. Continue efforts to translocate captive-bred Guam Rails to Rota for purposes of establishing a wild population in a snake-free environment.
9. Continue to monitor the populations of Common Moorhen and develop an appropriate habitat improvement and development program.
10. Considerable effort should be made to eradicate both groups of lovebirds at Tumon Bay as soon as possible.

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Report prepared by: Celestino F. Aguon and Gary J. Wiles

APPENDIX A

Damage to Wildlife and Other Natural Resources by Typhoon Russ

Guam received high winds and surf from Typhoon Russ throughout the evening of 20-21 December 1990. The storm's closest point of approach occurred at 3:00 a.m. on 21 December, when the eye passed about 20 miles south of the island. Sustained wind speeds were estimated at 120 mph in Merizo, 90-100 mph in central Guam, and 60-70 mph at Andersen Air Force Base. Winds from the typhoon were predominantly from the northeast, east, and southeast. Damage to homes and other buildings was most severe in the southern villages of Merizo, Umatac, and Inarajan, but also occurred to a lesser extent, throughout the rest of the island. Flooding from high surf occurred predominantly in the southeastern corner of the island. High winds and surf destroyed much of the Cocos Island Resort, causing it to be permanently closed. DAWR staff conducted damage assessments of the island's wildlife and terrestrial habitats from 23 December to 2 January. Additional surveys were conducted on Cocos Island from 27 December to 16 January and will be described separately in a second report.

Habitat damage from Typhoon Russ was greatest in southern Guam. Major blowdowns of trees were generally uncommon and tree damage was limited primarily to defoliation and limb breakage. Most fallen trees were outside of forests in relatively open and unprotected locations such as in villages and along fields and roadsides. Along the coast between Inarajan and Merizo, where heavy surf washed out several sections of Highway 4, broadleaf trees and shoreline shrubs in strand vegetation were completely defoliated in many areas. Further inland, forests in lowlands and on windward (northeast, east, and southeast) hillsides were also largely denuded. Coconut trees and *Casuarina equisetifolia* generally survived the storm in the best condition, while tangantangan and *Hibiscus tiliaceus* suffered more damage than most other species.

Several tracts of forest in southern Guam were examined from overlooks for damage. The Madog and Chagane River valleys in Umatac and the Talofoto River valley in Talofoto received extensive damage, with the forest canopies almost entirely defoliated. Some blowdowns of large trees occurred in the Madog valley, while in the Chagane valley, only a few coconut trees were knocked over but all exhibited crowns that were severely wind blown. Forests on the tall mountain ridgeline on western Naval Magazine suffered much defoliation but contained few blowdowns of large trees. In the hilly Mahlac and Maagas River valleys on the eastern side of Naval Magazine, forests received only moderate damage with trees exhibiting less foliage loss and limb breakage. Most of the damage in this area was confined to the windward sides of hills.

Vegetation was severely damaged or washed away on the small offshore islets in southeastern Guam, with heavy surf appearing to be responsible for most of the losses. *Pemphis* vegetation was stripped of nearly all its foliage and smaller branches on Asgadao, Fofos, and Agrigan Islands. On Asgadao Island, the only prominent vegetation remaining after the storm was a battered stand of brown *Casuarina* in the center of the island. A small coral islet across from Jeff's Pirates Cove in Ipan, which was heavily covered in *Pemphis* before the storm, also lost virtually all of its leafy foliage.

Forest damage and defoliation was minor to moderate in northern Guam, depending on local topography, height of individual trees, and other factors. Defoliation was estimated at about 50% on Pati Point on Andersen Air Force Base. Many emergent trees at Northwest

Field and the Conventional Weapons Storage Area were completely defoliated and had one or more major limbs broken.

The observed effects of Typhoon Russ on various wildlife species are described below.

Island Swiftlets - A count conducted at the Firebreak 4 Cave on Naval Magazine on 2 January recorded a total of 383 birds in the colony. This number is similar to pre-storm counts. Evidence suggested that there was little disturbance inside the cave during the typhoon. This evidence included: 1) the vegetation outside both entrances of the cave was found to be intact, 2) little foliage was blown inside the entrances of the cave, 3) few, if any, swiftlet nests were knocked to the floor of the cave, and 4) the presence of various sizes of chicks in a number of nests after the typhoon indicates that they or their eggs survived the storm.

Fachi Cave on Naval Magazine was briefly visited on 26 December five days after the storm. The water level in the sinkhole outside the northeast entrance was only 2 feet lower than the top of the entrance's roof. Assuming that the water level had already fallen some, it would seem likely that flooding closed off the cave during the night of the storm or on the following day (note: there was no other appreciable rainfall for about a week before or after the storm). It was not determined during our visit whether the colony still inhabited the cave, however, several birds were seen flying among the trees in front of the entrance. A sudden flood of this type during a storm would potentially threaten the colony's existence because high winds or darkness may have made it impossible for birds to escape the cave.

Micronesian Starlings - Initial counts on Cocos Island on 28 December indicated that starling numbers declined by about 37% as compared to the last previous count made in June 1990. Post-storm surveys suggested there was a shortage of suitable foods for starlings. On 15 and 16 January, two weak birds were found that were unable to fly and presumably suffering from starvation. Supplemental feeding for the birds was started by DAWR staff, who placed split-open coconuts in trees and on the ground at 3-5 stations on several trips, and was continued by resort staff. Some of these food stations attracted large numbers of starlings within 15-20 minutes. Emigration of starlings from Cocos Island to Guam could have resulted in further declines of the population on the island, although this was not documented. Single starlings were heard on the west side of Merizo on 23 December in an area of badly damaged coconut trees and in the center of Umatac village on 9 January. These may have been birds resident to those before the typhoon.

Mariana Crows - Five known nests, one with eggs and four under construction, were destroyed by high winds in Northwest Field and the Conventional Weapons Storage Area on AAFB. There was no evidence of mortality to adult birds. Up to 90% of the tall emergent trees (*Eleaocarpus joga* and *Tristeropsis obtusangula*) suitable for nesting suffered foliage loss and breakage of one or more large limbs.

Marianas Fruit Bats - Pre-storm and post-storm counts were conducted at the colonies on Pati Point. One hundred fifty-eight bats were counted at Roosts 20 and one on 19 December as compared with 210 bats on 22 December. The increase in numbers was most likely a result of better visibility caused by the defoliation of the *Ficus* trees used for roosting. These trees suffered no other noticeable damage. No changes in the roosting patterns of the bats were detected. Fruit loss was probably high throughout the forest in northern Guam and is likely to reduce temporarily the food sources of the bats.

Common Moorhens - A nest with eggs was lost at the Barrigada Ponding Basin. It was observed on a floating board on 16 December, but was missing on 23 December. A rise of about 1 foot in the pond's water level occurred during the typhoon, thus, the loss of the

nest was caused either by high water or strong winds. An adult bird was seen in the pond on 23 December.

The *Phragmites karka* in the small central marsh on the east side of Naval Magazine (located directly below the swiftlet cave) appeared badly wind blown during a site visit on 4 January, but there did not appear to be a significant loss of cover for moorhens. Two adults were observed in shorter reeds (*Eleocharis ochrostachys*) in the center of the pond.

Yellow Bitterns - The small coral islet across from Jeff's Pirates Cove in Ipan, Talofofo, which was commonly used by bitterns for nesting and roosting, lost its covering of *Pemphis* foliage during the storm. The islet now appears to be temporarily unsuitable for nesting. Similar nesting habitat for bitterns on other small islets and Cocos Island was also probably destroyed temporarily.

Pacific Reef-Herons - At least four individual birds were observed on Cocos Island after the storm. Two coconut trees known to have held reef-heron nests in the past survived the typhoon.

Black Noddies - The large colony of these birds on Cocos Island appeared to have survived the storm in relatively good condition, although DAWR staff did locate the carcasses of 20 birds in storm debris under roosting trees. An estimated 100-200 birds may have been killed out of an estimated 1,500-1,700 birds in the colony.

Black Francolin - No attempts were made to look for storm-related mortality of francolins. Grasslands in southern Guam were heavily battered by high winds, but plenty of protective cover remained for this species. However, changes in food sources, such as grass seeds and herbaceous fruits, could have occurred after the storm.

SUMMARY

Typhoon Russ caused severe damage to the island's natural habitats, particularly in the southern half of Guam. These habitats should recover in six months to several years. Most species of wildlife did not appear to suffer major mortality directly from the typhoon, although post-typhoon shortages of insects and wild fruits could further impact some species.

Report prepared by: Gary Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-28

SUB-PROJECT NO.: W-5

STUDY NO.: 1

JOB NO.: 2

JOB TITLE: Natural History, Biology, and Habitat Protection for Marianas Fruit Bats.

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Guam's fruit bat population is currently estimated at 370-450 animals, which is a slight decline of about 20 bats from the previous year. Bat colonies used four roosts on Pati Point during the year. One known case of illegal hunting of fruit bats occurred during the year. In FY91, 7,553 frozen fruit bats were imported to Guam from other islands for human consumption, a decrease of 24.9% from the previous year. Assistance was given to the Republic of Palau and the U.S. Fish and Wildlife Service (USFWS) during a month-long census of bats in April-May.

BACKGROUND

The Marianas fruit bat (*Pteropus mariannus mariannus*) is endemic to the Mariana Islands and has been under investigation by the Guam Division of Aquatic and Wildlife Resources (DAWR) since 1962 (DAWR 1964-1990). These bats, considered a delicacy by Chamorro residents, steadily declined in number during the 1960s (Perez 1972). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in suitable habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increased human population pressures that resulted in overhunting and habitat loss, commercial exploitation of bats as food, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). The Marianas fruit bat and the little Marianas fruit bat (*P. tokudae*) finally received full protection from hunting in 1973. Both species were placed on Guam's territorial Endangered Species List in 1981 and on the U.S. Endangered Species List in 1984, but *P. tokudae* is now thought to be extinct. The island's population of Marianas fruit bats grew substantially to an estimated 850 - 1,000 animals between 1980 and 1982, probably from immigration of bats from Rota (Wiles 1987a, Wiles and Glass 1990). However, numbers have declined since 1983 because of continued illegal hunting and suspected predation on bats by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b). Guam's fruit bat population was estimated at 390-475 animals in FY90 (DAWR 1990).

OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as called for in the Fruit Bat Recovery Plan.

PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) as initiated in the late 1970s.

- a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.
 - b. Conduct monthly censuses at known bat colonies on Guam.
 - c. Assist the CNMI Division of Fish and Wildlife (CNMIDFW) with surveys of fruit bats on other islands as needed.
2. Record information on the behavior and reproduction of fruit bats in colonies.
 3. Determine habitat use of fruit bats. Visit abandoned roost colonies and record information about terrain and the size and abundance of vegetation present.
 4. Monitor fruit bat imports to Guam from other islands in Micronesia and the Pacific.
 5. Investigate illegal hunting of fruit bats on Guam.
 - a. Visit abandoned roosting sites of colonies to determine illegal hunting effort.
 - b. Assist Conservation Officers with investigations of bat poaching.

RESULTS

Locations of Bat Colonies on Guam

During FY91, colonies of fruit bats roosted at four known locations on Pati Point, each of which was used in previous years (DAWR 1988). Roost 20 was inhabited during three periods that totalled about 6 months (Tables 1 and 2). Roost 1, a favored site in previous years (DAWR 1987-1990), was occupied by large numbers of bats from early March to late July. Smaller numbers of animals (probably mainly bachelor males) also roosted there from October to early January, and a small colony with about 75 bats was present in late September. Roosts 15 and 17 were used only temporarily for a few days or several weeks. The main colony's location from 4-30 August was not determined.

Table 1. Approximate dates of use of four roosts used by colonies of Marianas fruit bats on Guam in FY91.

Roost number	Roost location	Approximate periods of use by bats
1	North Pati Point	7 Oct 90-3 Jan 91, 6 Mar-27 July, 18 Sept-present
15	North Pati Point	27-30 July 91
17	North Pati Point	7 Feb-6 Mar 91, 18 Sept-present
20	East Pati Point	6 June 90-7 Feb 91, 27 July-4 Aug, 30 Aug*-present
unknown roost	unknown	4-30 Aug 91*

*the colony may have been present at Roost 1 or 17 for all or part of this period, or may have already relocated to Roost 20 prior to 30 August.

Table 2. Counts of Marianas fruit bats at roosts on Andersen AFB, Guam in FY91.

Date	Roost Number									Total
	1	14	15	16	17	18	19	20	21	
18 Oct 1990	+(9)	-	0	0	-	0	0	224	-	x
28 Nov	2	-	0	0	-	0	0	210	-	212
19 Dec	+(8)	-	0	0	-	0	0	158	-	x
22 Dec	3	-	0	0	-	0	0	214	-	217
18 Jan 1991	0	-	0	0	-	0	0	253	-	253
28 Feb	0	0	0	0	355	0	0	0	0	355
12 Mar	+	0	-	-	0	-	-	-	-	x
28 Mar	341	-	-	-	-	-	-	-	-	341
28 May	294	-	-	-	-	-	-	-	-	294
2 July	272	-	-	-	-	-	-	-	-	272
30 July	0	0	37	0	0	0	0	155	-	192
1 Aug	0	0	0	-	-	-	-	+	-	x
6 Aug	-	-	0	0	-	0	0	0	-	x
4 Sept	0	0	0	0	-	0	0	192	-	192
27 Sept	75	0	0	0	9	0	0	191	-	275

+ = Bats present at roost but no count made; () = minimum number of bats observed; - = site was not checked for bats; x = no total count made.

As in previous years, attempts were made to determine the reasons for colonies changing roost sites. Illegal hunting caused the abandonment of Roost 1 on 27-28 July (see Illegal Hunting). The colony relocated to Roost 20 within a few days after the incident, but abandoned that site on about 4 August during a several-day period with fairly strong winds blowing from the southwest. Storms and other unusual changes in wind direction were associated with past movements between roosts on Pati Point (DAWR 1988-1990). On 30 August, the colony was disturbed by one or more visiting F-15 jet fighters making repeated take-offs and landings. The planes were extremely loud and flew relatively low over Pati Point. The colony reassembled at Roost 20 within one or two days. Unfortunately, the location of the colony prior to the disturbance was unknown, making it impossible to determine whether aircraft noise actually caused a change of roost sites. Factors involved in other colony movements during the year were not determined, but site visits did not indicate that they were human-related.

Surveys of Fruit Bats on Guam

During FY91, censuses of fruit bats at colonies on Pati Point produced total counts ranging from a high of 355 animals in February to a low of 192 animals in July and September (Table 2). About 210-250 bats were recorded on surveys in the first four months of the year. Typhoon Russ did not appear to harm the colony when it passed the island on the evening of 20-21 December, although it did strip nearly all foliage from the roost trees. Counts at Roost 20 increased from 158 bats on 19 December to 214 bats on 22 December (Table 2), and was likely related to heavy defoliation of roost trees which improved the visibility of roosting animals. Counts suddenly increased to about 340-355 bats in February and March, then gradually declined to 272 animals in early July. After the poaching in late July, counts were much lower at about 190 bats until September. However, some of this reduction was probably related to bats being at Roost 20, where long-distance viewing probably resulted in some bats not being seen. In late September, numbers increased to 275 bats with the appearance of about 75 bats at Roost 1. Variation in counts during the year may have resulted from inter-colonial movements between the main roost and other smaller undiscovered roosts on the island, or from inter-island

movements between Guam and Rota. Noticeable increases of 75-100 bats during counts were possibly due to immigration from Rota.

An estimate of Guam's population of fruit bats at the end of FY91 was determined using the September count of 275 bats at Roosts 1 and 20. Because some individuals were probably hidden by thick foliage during that count, the total number of adults in the colony was likely to be 10-20% higher than the actual number recorded. In addition, based on previous observations (DAWR 1985), approximately 65% of the adults in the colonies were harem females. An estimated 10% of these animals probably possessed unweaned young. These figures provide an estimate of 302-330 adults and 20-21 juveniles, or a total of 322-351 bats, on Pati Point in September 1991.

Incidental daytime sightings of single fruit bats or pairs of bats were made during the year at Naval Facility (6 sightings), the Conventional Weapons Storage Area on AAFB (3 sightings), the area from Lonfit in Chalan Pago to a point about 2.5 km up the Sigua River valley (3 sightings), Northwest Field (2 sightings), Tarague Point (1 sighting), and Two Lovers Point (1 sighting). Only one sighting of a bat was recorded at night, this being at Two Lovers Point. Personnel at Naval Facility reported that they were in fact seeing individual animals on an almost daily basis between April and July. During a visit to the base at 1030 hrs on 11 July, DAWR staff saw two solitary bats sleeping in separate *Casuarina* trees on the cliff faces above the installation. Archaeological and environmental consultants occasionally saw bats during their surveys of the lower Sigua River valley and Lonfit area. A pair of bats was seen once.

Excluding bats residing in the colony at Pati Point, an estimated 25-50 fruit bats are still believed to live solitarily or in small groups along the island's northern cliffline which extends from Bijia Point to Iates Point. An additional 25-50 animals probably inhabit Naval Magazine and other forested areas in southern Guam. Based on these figures, Guam's island-wide population of fruit bats at the end of FY91 was estimated to contain about 370-450 animals.

Surveys of Fruit Bats on Other Islands

The DAWR assisted the Republic of Palau and the USFWS with a survey of fruit bats (*P. m. pelewensis*) in Palau from 21 April to 21 May. About 60-70 counts were conducted, ranging from Angaur northward to Kayangel Atoll. Data analyses have not yet been completed, but the population was judged to be moderate in size. This is in spite of the large volume of bats that have been exported to the Marianas during the last 20 years (Wiles and Payne 1986; Wiles, in press). The highest counts were obtained near Koror as bats dispersed from roosts on large inaccessible limestone islands, known as the Rock Islands. Most of the population appears to roost solitarily, although some colonies with 10 to about 100 bats were found. Information was also gathered on social behavior within roosts, food habits, and hunting pressure. A final report on the survey will be prepared and will discuss management recommendations.

The DAWR did not participate in bat surveys on Rota or other islands in the CNMI this year.

Natural History

Reproductive data and other observations on the natural history of fruit bats on Guam were not gathered during FY91 because of limitations in manpower.

Illegal Hunting

Poaching has long been a major cause of mortality of *P. mariannus* in the southern Mariana Islands (Wiles 1987a, Wiles et al. 1989, Stinson et al., in press). One known case of illegal hunting occurred on Guam in FY91. Six recently fired 20-gauge shotgun shells were found beneath the main roost tree at Roost 1 on 1 August. The colony had been present at the site on 26 July, but was gone on 30 July. It was probably raided sometime during the weekend of 27-28 July. Because of light wind conditions, the seas along the north shore of Pati Point were relatively calm at the time and may have allowed the poacher(s) access to the colony. The DAWR also obtained a tip that linked workers from the Andersen AFB golf course with the shooting, which would suggest that the men may have been familiar enough with the general area to have entered by land and crossed over the top of Pati Point.

Fruit Bat Imports

A total of 34,921 fruit bats were requested for import during FY91 (Table 3), a decrease of 30.1% from the previous year (DAWR 1990). All requests were made for *P. m. pelewensis* from Palau, although several importers made inquiries about the legality of obtaining bats from the Solomons, Indonesia, and the Philippines. The number of import permits issued by the DAWR declined to 416 for the year, a drop of 33.5% from FY90. Approximately 19.2% of all import permits issued by the DAWR in FY91 had fruit bats listed as one of the items requested.

FY91 was the first full year in which recent CITES trade restrictions on fruit bats were in effect. An estimated 7,553 frozen fruit bats in 227 shipments were shipped to Guam from other islands during the year, with nearly all bats coming from Palau (Table 4). These figures represent a 24.9% decrease in the estimated number of imported bats and a 28.8% decrease in the total number of shipments received when compared to FY90 (DAWR 1990). Imports from Palau increased by about 2,100 animals. The increase probably reflects the continued demand for fruit bats as other sources of bats are being cut off.

During FY91, 574 fruit bats in 43 shipments were confiscated by the Guam Customs and Quarantine Division and USFWS upon entry into Guam. These figures represented 7.6% of the total number of bats brought to the island and 18.9% of the shipments received during the year. Shipments were seized for a variety of violations including 1) the presence of bats killed with shotguns in shipments from Palau, which violated Palau firearms laws and the Lacey Act, 2) lack of import permits or certificates of origin, and 3) violation of CITES restrictions. The USFWS stationed its first permanent wildlife inspector on Guam in FY91. George Phocas began working as the inspector on 12 April.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota can cause large numbers of bats to move to Guam (Wiles and Glass 1990).
2. Continue observations at Guam's bat colonies. Information on reproductive biology, behavior, and social organization will be used to supplement data already gathered.
3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.

Table 3. Numbers of frozen fruit bats requested for import to Guam from October 1, 1990 to September 30, 1991.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	No. of Permits Issued
Palau	2,338	3,804	3,930	2,850	3,195	2,800	4,067	2,661	1,165	2,330	2,286	3,495	34,921	416

Table 4. Numbers of frozen fruit bats imported to Guam from October 1, 1990 to September 30, 1991.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total*	No. of Shipments Received*	No. of Bats Confiscated	No. of Shipments Confiscated
Palau	726	1,613	581	368	530	675	334	390	303	350	508	1,026	7,404	218	425	34
Pohnpei	2		7									107	116	3	116	3
Unknown		9		8									17	2	17	2
Yap	9							2					11	2	11	2
Saipan		1 ^a							4 ^b				5 ^c	2	5 ^c	2
TOTAL	737	1,623	588	376	530	675	334	392	307	350	508	1,133	7,553	227	574	43

*Totals include confiscated bats.

^aBat was identified as *P. m. yapensis* (K.F. Koopman, pers. comm.).

^bThis shipment, which was purchased on Saipan, appeared to contain *Acerodon jubatus* or *Pteropus vampyrus* from the Philippines.

^cTotal does not include a shipment of 132 bats from Saipan that was refused entry in September and was returned to Saipan. It appeared to contain mainly *P. m. pelewensis* and some bats of a second species not yet identified.

4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.
5. Known bat roosting and foraging areas should be patrolled regularly by Conservation Officers. Part of their effort should be aimed at maintaining a visible presence at Jinapsan and Pajon Points, where poaching has been a serious problem in previous years.
6. Form a cooperative bat research program with the CNMI to collect information on the locations and sizes of colonies, reproductive biology and behavior within colonies. Most of the work done under this program would be conducted on Rota where a moderately-sized bat population is found but where logistics prevent the CNMI from doing extensive field work. Emphasis of this project would be to identify colonies should they move between Guam and Rota.
7. Continue to monitor fruit bat imports entering Guam.

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Report prepared by: Gary J. Wiles

**JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO.: FW-2R-28
SUB-PROJECT NO.: W-5

JOB TITLE: Roost Site Characteristics of Marianas Fruit Bats.

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

No significant effort was expended on this job during this segment.

Report Prepared by: Gary J. Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-6
STUDY NO.: 4
JOB NO.: 1

JOB TITLE: Captive Breeding Endangered Native Birds.

PERIOD COVERED: October 1, 1990 to September 30, 1991.

SUMMARY

During FY91, the number of Guam Rails at the Division of Aquatic and Wildlife Resources (DAWR) facility increased to 81. The Guam Micronesian Kingfisher population in captivity at mainland U.S. zoos, increased to more than 70. In December 1990, Typhoon Roy destroyed the building used for food preparation for the captive breeding program. In addition, one of the wooden 12-stall holding aviaries was destroyed by the storm. Construction of a replacement 12-stall aviary was completed in March 1991.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the DAWR, member zoos of the American Association of Zoological Parks and Aquariums (AAZPA) and the U.S. Fish and Wildlife Service (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982, at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately, by 1984, attempts at captive breeding three of these species, the Bridled White-eye, *Zosterops c. conspicillata*, Rufous Fantail, *Rhipidura rufifrons uraniae*, and the Guam Flycatcher, *Miagra freycineti*, were abandoned due to their virtual disappearance from the wild (DAWR 1984).

The Guam Rail, *Rallus owstoni*, and Guam subspecies of the Micronesian Kingfisher, *Halcyon c. cinnamomina*, were successfully brought into captivity (DAWR 1983-6), with the capture of 19 and 31 founder birds respectively. Rails first bred at the DAWR's facility on Guam and at the Conservation and Research Center (CRC) of the National Zoological Park in 1984. Kingfishers were first bred at three mainland U.S. zoos (Bronx Zoo, Philadelphia Zoo, and the CRC of National Zoological Park) in 1985.

During FY88, the first studbook for the Micronesian Kingfisher was published by the Philadelphia Zoo (Bahner 1988). The kingfisher was officially designated as a Species Survival Program species by the AAZPA. Beth Bahner of the Philadelphia Zoo was officially designated studbook keeper for the kingfisher. Dr. Scott Derrickson, Curator of Birds, Conservation and Research Center, National Zoological Park, Smithsonian Institution, Front Royal, Virginia, continued as coordinator for AAZPA's Guam Rail program.

During FY89, the number of Guam Rails at the DAWR facility increased from 37 to 61. The captive rail population at mainland U.S. zoos increased to more than 77. The Guam

Micronesian Kingfisher population in captivity at mainland U.S. zoos, increased to 58. Construction was completed to enlarge the DAWR rail facility to a capacity of 100 rails.

During FY90, the number of Guam Rails at the DAWR facility increased from 61 to 78. In addition, 15 rails from the Guam facility were released on Rota as a part of the introduction program. The Guam Micronesian Kingfisher population in captivity at mainland U.S. zoos, increased to 62. Rehabilitation of holding aviaries on Guam was completed.

OBJECTIVES

Implement and manage a captive breeding program for the Guam Rail and other endangered endemic birds by setting up facilities on Guam and at zoos on the mainland U.S. with the assistance of member zoos of the AAZPA. Produce enough rails to support the introduction effort on Rota.

PROCEDURES

1. Develop plans and seek funding for the construction of at least six 12-stall holding aviaries to replace existing wooden aviaries that have deteriorated from weather and typhoons. Add additional holding aviaries as the need arises.
2. Develop plans and funding for the construction of a building to support food preparation areas, incubator and brooding equipment usage and storage of supplies and equipment.
3. Continue development of a cooperative captive breeding program for the Guam Rail and Micronesian Kingfisher with the AAZPA and its member zoos.
4. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.
6. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
7. Breed rails in sufficient numbers to support the continuing introduction of the Guam Rail to Rota, Commonwealth of the Northern Mariana Islands, begun in December 1989.

RESULTS

The number of Guam Rails at the DAWR's facility on Guam fluctuated over the years as rails were hatched, birds were released on Rota, rails were imported from the mainland U.S. zoos and several rails died from cage mate aggression. A total of 11 chicks were hatched from 5 clutches. There were 7 rail fatalities at the Guam facility. Four were adult rails that died from trauma inflicted by their cage mates while attempts were made to breed them. Three died of unknown causes. On February 4, 1991, 33 rails were released on Rota as a part of efforts to establish a population in the wild in a snake free habitat. Two shipments of 15 rails each were received from the CRC. The first arrived on April 15, 1991, and the second on September 26, 1991. There are now more than 180 rails in captivity on Guam and at 18 mainland U.S. zoos.

Typhoon Roy passed over Guam in December 1990 and winds from the storm destroyed one of the 12-stall holding aviaries as well as the food preparation building. A new 12-stall holding aviary was constructed by March 1991. The capacity of the Guam facility remains at 92. Funding has been secured and plans are underway to construct a new food preparation building.

Dr. Velma Harper, a local Guam veterinarian successfully sexed 15 rails by surgical laparoscopy.

Micronesian Kingfishers continue to be captive bred at 15 mainland U.S. zoos (Bahner 1990). As of August 31, 1991, there were more than 70 Micronesian Kingfishers in captivity at 14 mainland U.S. zoos (Derrickson per. comm.). Cannibalism of chicks by parent kingfishers continues to be the major cause of mortality of young kingfishers.

RECOMMENDATIONS

1. Develop plans for and construct at least six steel-framed 12-stall holding aviaries to replace existing wooden aviaries that have deteriorated from weather and typhoons. Add additional holding aviaries, as the need arises.
2. Develop plans and construct a building to support food preparation areas, incubator and brooding equipment usage and storage of supplies and equipment.
3. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam Rail and Micronesian Kingfisher with the AAZPA and its member zoos.
4. Develop techniques for the successful release of captive-reared birds in the wild once the factors responsible for their decline have been controlled.
5. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
6. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
7. Breed rails in sufficient numbers to support the continuing introduction of the Guam Rail to Rota, Commonwealth of the Northern Mariana Islands, begun in December 1989.

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Report prepared by: Robert E. Beck, Jr.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-6

STUDY NO.: 4

JOB NO.: 2

JOB TITLE: Development of an Experimental Population of Guam Rails on Cocos Island or in the Commonwealth of the Northern Mariana Islands.

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

I Chiugai was chosen as the site for the second release of Guam Rails on Rota. On February 4, 1991, 33 rails were released on Rota. This release appeared to be more successful than the January 1990 release at the Sabana. Planning continues for a third release of rails in FY91.

BACKGROUND

Since the creation in 1960 of the Guam Division of Aquatic and Wildlife Resources (DAWR), census data from roadside counts, station counts, and transect counts have documented the reduction in range and numbers of the Guam Rail, *Rallus owstoni*, and other native birds (DAWR 1961-1987; Jenkins 1983; Engbring and Ramsey 1984). Predation by the brown tree snake, *Boiga irregularis*, is believed to be the major factor contributing to recent declines in native bird populations (Savidge 1986, 1987; Conry 1988). Research efforts are presently underway to develop methods for controlling rail predation by the brown tree snake. However, it is not likely that we will be able to adequately control snake predation on Guam so that we will be able to introduce the rail back into the wild there in the near future.

A captive breeding program for the Guam Rail was successfully begun in 1983 on Guam and at mainland U.S. zoos in cooperation with the American Association of Zoological Parks and Aquariums (AAZPA) (DAWR 1984-1987; Derrickson 1986). Guam Rails were first brought into captivity in 1983 on Guam and bred at the DAWR's rail facility in the spring of 1984 (DAWR 1983-4). By September 1987, there were more than 101 rails in captivity on Guam and at stateside zoos.

The DAWR developed plans to introduce the Guam Rail to Rota in order to develop a self-sustaining wild population of rails that will not undergo "domestication" from captive breeding. It is hoped that the experience gained in introducing the rails to Rota will provide valuable information useful for future introductions on Guam. The Rota population may also serve as a partial source of birds for use in reintroducing the rail to Guam when snake predation has been controlled there.

During FY87 a cooperative agreement was signed between the Government of Guam, Commonwealth of the Northern Mariana Islands (CNMI), and the U.S. Fish and Wildlife Service (USFWS) outlining the responsibilities of each entity for the introduction. An environmental assessment was prepared for the USFWS covering the introduction of the

Guam Rail to Rota and forwarded to Environmental Services, USFWS, Honolulu. Upon review, it was mutually decided to additionally conduct an insect and reptile survey of Rota to discover the presence of possible endangered species. Dr. Stuart Pimm, Professor of Zoology, University of Tennessee, and the DAWR reached agreement by which a graduate student from the University of Tennessee will reside on Rota for at least three years monitoring the rail introduction, in cooperation with the DAWR, as a part of his dissertation research. In addition, Dr. Pimm, with the support of the DAWR, applied for research grants to support the monitoring study. In April, 1987, staff from the DAWR, Dr. Pimm, and Phil Glass from the CNMI Fish and Wildlife Division, visited Rota to investigate possible sites for the introduction. Sites in Palii and Sinapolo were tentatively selected. In addition, visits were made to various Rota government officials to update them on the status of the project.

During FY88, captive breeding efforts continued at the DAWR facility and U.S. zoos with the captive population numbering over 120 rails. Contracts for construction of 22 additional rail breeding aviaries on Guam were let and construction began.

A survey of Rota for reptiles was conducted by staff from the DAWR and USFWS in the fall of 1987. Staff of the University of Guam conducted an insect survey of Rota in February 1988. The results of both surveys, which found no endangered species, were submitted to the USFWS, Honolulu for inclusion in the Environmental Assessment for the project.

In May 1988, Dr. Scott Derrickson, National Zoological Park, and DAWR staff visited Rota looking for additional possible introduction sites. A site on the Sabana was selected for the initial introduction. Dr. Derrickson also transported rails to Guam to broaden the genetic variation of the Guam captive population in preparation for breeding birds for release on Rota. In June 1988, DAWR staff, with the assistance of the Rota Department of Natural Resources, constructed three 12-stall holding aviaries at the Sabana introduction site. Radio telemetry equipment to be used to monitor the success of the introduction was purchased by the DAWR.

Dr. Pimm was successful in obtaining several grants from international conservation organizations to support his efforts in monitoring the introduction on Rota. Using these funds, a 1/2 ton pickup truck was purchased on Rota for use by the graduate student and staff monitoring the introduction.

In July, 1989, the DAWR was informed by the USFWS that there would be a delay in publication of the Final Rule required for designating the "Experimental Population" status of the rails released on Rota. Conservation organizations were notified of the delay so that coordination of their funding could be rearranged to avoid further delay of implementation of the monitoring project.

After the permit to establish an experimental population of Guam Rails from captive bred population was published in the *Federal Register*, 22 rails was released at the Sabana on Rota during three releases in December 1989 and January 1990. All but one were released with radio transmitters attached in order to monitor their dispersal, mortality and possible breeding success. Of the 22 released birds, the whereabouts of nine are unknown as their radios failed, four were killed by vehicles, two were killed by cats, two apparently died of starvation, one died of poisoning, and four died of unknown causes.

PROCEDURES

1. Continue to captive breed Guam Rails both on Guam and at mainland U.S. zoos.

2. Continue to develop techniques and methods for introduction of the Guam Rail to Rota.
3. Implement disease prevention protocol with rails on Guam prior to release on Rota as needed.
4. Carry out additional introductions of the Guam Rail to Rota as rails become available. Review monitoring results from the initial release and modify techniques, as appropriate, for the second release.
5. Monitor the success of continuing introductions of Guam Rails to Rota.
6. Seek funding from conservation organizations to support the monitoring of the introduced rail population.

RESULTS

A review of the results of the first rail release conducted on Rota in December 1989 and January 1990, found the following:

1. Rail transmitter electronics failed at an unacceptable rate so that monitoring staff was unable to follow the results of the release beyond several months.
2. The rails dispersed more rapidly and extensively than expected. It was expected that the 2-3 weeks the rails spent at the Sabana aviaries would acclimatize them to Rota and allow them to develop some site fidelity. However, upon release, they used the dirt roads in the vicinity of the aviaries to travel up to 3 km from the release site. Dense vegetation was thought to be the reason for their use of the roads.
3. The largest cause of mortality among the rails was from automobiles as the birds dispersed along roads.
4. Several rails were not released and were instead returned to Guam due to the apparent stress of the holding situation on Rota. This would include transporting the rails, attaching the radio harnesses, and the large amount of human activity around the holding aviaries on the Sabana associated with feeding, daily maintenance, and the release of other rails.

Based upon the above observations, a new rail release protocol and release site were chosen for the second release which occurred on February 4, 1991. A coastal area above the cliffline at I Chiugai, which the CNMI has designated as a conservation area, was selected for the release site. This area had much less dense ground cover than the original Sabana release site. Vehicular use of the area was much less than the Sabana site. For this second release, it was decided to attach radio transmitters on the males to reduce possible stress on female rails and not to interfere with breeding. Rails were to be shipped directly from Guam and released immediately upon being transported to the release site. Radio transmitters were attached on Guam at least one week prior to transport to Rota. No aviary holding facilities were constructed at the I Chiugai release site.

Initial monitoring for the second release was done by the graduate student with the assistance of a CNMI Fish and Wildlife technician. The student returned to the University of Tennessee in late March; the CNMI Fish and Wildlife technician continued weekly monitoring with assistance provided by DAWR staff on a monthly basis.

Results of the monitoring were sketchy at best because of the failure of the harnesses on the majority of the radios. Of the 13 radios attached to male rails, 4 malfunctioned because of electronic failure, and 6 had broken harnesses. The remaining 3 radios were not recovered and their status remain undetermined. Virtually no rails were observed without the assistance of radio transmitters. Playback of rail calls failed to elicit responses from rails during the entire monitoring. This is consistent with the results for the January 1990 release and probably indicates that the newly released rails had not yet established strong territories. Several vocalizations were heard by the graduate student near the release site for several weeks. Mortalities included monitor lizard predation, cat predation and unknown causes. No vehicular mortality was reported. As of March 19, 1991, five male rails were still being tracked. Assuming that an equal number of female rails were still left in the wild (females could not be tracked as they had no radios attached), at least one-third of the rails may still be at or near the release site more than three months after the release. Preliminary results indicated that many rails, for as long as they could be tracked, stayed in relatively small areas that presumably were being used as territories. Because females were not tracked, it was not determined if any pairing had occurred.

In conclusion, the second release was more successful than the January 1990 release for the following reasons:

1. No rails suffered from loss of weight due to stress before release.
2. Vehicular mortality, the most important cause of mortality during the first release, was eliminated during this release.
3. The rails' dispersal was reduced greatly, when compared to the initial 1990 release, with most birds remaining near the release site in what appeared to be territories.
4. Some vocalizations were heard from the rails, perhaps indicating that territories were being set up. However, the lack of response to tape recorded playback calls does not support this hypothesis.

Reliability of the radio electronics was improved over the first release, but the greater longevity of the radios was canceled out by the failure of most of the harnesses that attached the radios to the rails. This fact coupled with the decision not to attach transmitters to females, did not allow tracking of rails for as long as 18 months as planned. The last radios were either recovered or were not located by June 11, 1991. Because staff has not yet been able to track rails for the desired 12-18 months after release, radios should be attached to all rails on the next release.

RECOMMENDATIONS

1. Continue to captive breed Guam Rails needed for the Rota introduction, both on Guam and at mainland U.S. zoos.
2. Continue to develop techniques and methods for introduction of the rail to Rota.
3. Implement disease prevention protocol with rails on Guam prior to release on Rota.
4. Continue to introduce Guam Rails to Rota.
5. Monitor the release of rails on Rota using radio transmitters attached to all rails for at least the next release.

6. Continue to seek funding from conservation organizations to support the monitoring of the introduced rail population.

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Report prepared by: Robert E. Beck, Jr.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: E-1-6

STUDY NO: 7

JOB NO: 1

JOB TITLE: Biology of the Brown Tree Snake

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Studies on the impact of the brown tree snake, *Boiga irregularis*, on Guam's fauna, human community, and on the ecology and biology of the snake are in progress. Biological profiles of the ubiquitous prey base (lizards) continue. The studies presented here are aimed at a lizard community that is found in the last snake-free area on Guam [Cocos (=Dano) Island]. Studies were also initiated on a potential native biological control species, the mangrove monitor (*Varanus indicus*). Feeding strategies of two populations, one from a snake-free area (Rota) and the other from Guam, were compared. A statistical summary of recent data compiled on *B. irregularis* bites reported to medical facilities is presented.

BACKGROUND

Data indicate that *B. irregularis* has been responsible for the demise of most of the native forest dwelling avifauna (Savidge, 1987) of Guam. Impacts on introduced birds have also been documented (Conry, 1988). Additionally, at least two species of lizards probably suffered the same fate (*Gehyra oceanica* and *Perochirus ateles*). Significant damages in terms of power outages (Fritts, et al., 1987), agricultural impacts (Fritts and McCoid, 1991), and human health risks (Fritts, et al., 1990) have also been documented. Because many of the frugivorous, granivorous and insectivorous vertebrates have been eliminated by *B. irregularis* predation, long term changes in both insect abundance and flora have been predicted (McCoid, 1991).

OBJECTIVES

In order to control and contain *B. irregularis* populations on Guam, an intimate knowledge of populations and their effects must be gained. These objectives must also include insights into the population biology of their most ubiquitous prey base (lizards) and a native potential control agent (*V. indicus*). To determine impacts in terms of human health risks, bites by *B. irregularis* continue to be documented via a questionnaire distributed to medical facilities on Guam.

PROCEDURES

1. Collect and analyze lizard populations from Cocos Island.
2. Collect, analyze, and compare two populations (Rota and Guam Islands) of the mangrove monitor (*V. indicus*).

3. Collate and interpret information associated with recent bites of *B. irregularis* reported to medical facilities on Guam.

RESULTS

Cocos Island Lizard Populations

BACKGROUND

Cocos (Dano) Island, is a small, fringing atoll approximately 2 km southwest of Guam. Fortuitously, *B. irregularis* have yet to become established on this atoll, although there are undocumented reports of three to five snakes killed or sighted on Cocos Island over the past several years. The herpetofauna of this atoll is, arguably, the most diverse in the entire Mariana archipelago with a total of 13 species. These species are geckos (*Gehyra mutilata*, *G. oceanica*, *Perochirus ateles*, *Hemidactylus frenatus*, and *Lepidodactylus lugubris*), skinks (*Emoia atrocostata*, *E. slevini*, *E. cyanura*, *E. caeruleocauda*, *Carlia* cf. *fusca*, and *Cryptoblepharus poecilopleurus*), a monitor (*Varanus indicus*), and a toad (*Bufo marinus*).

The Cocos Island Resort is undergoing intensive rebuilding after its destruction by Typhoon Russ in December 1990. Large amounts of materials and equipment are moved daily to the island. To ensure that Cocos Island remains snake-free, a snake inspection protocol was established to minimize the chances that *B. irregularis* would be accidentally transported to the island. However, should this deleterious pest become established on the island, studies were initiated to establish base-line population characteristics of the lizard fauna to document changes that may be associated with *B. irregularis* infestation. These data will also be useful in reconstructing population characteristics of Guam lizards prior to the possible introduction of the brown tree snake.

MATERIALS and METHODS

Lizards were surveyed by two primary methods (visual surveys and trapping). Nocturnal lizards (geckos) were sampled by walking a predetermined route in the resort and recording and/or collecting lizards. Generally, surveys were conducted between 1830 and 2300 h. These data can be expressed in terms of lizards per unit time, or species percentage per total lizards observed. Diurnal lizards (skinks) were sampled by visual surveys and by the use of Victor Brand 'sticky' traps. Visual surveys (usually between 0700 and 1000 h) were used on arboreal skinks (*C. poecilopleurus*) and the results expressed in terms of lizards per unit time. Trapping was conducted to assess populations of terrestrial skinks and the results can be expressed in terms of lizards caught per trap hour, or species percentage per total lizards observed.

When sampling forested habitats, the trapping protocol consisted of either 40 or 80 traps set along the edge of a bulldozed road. Two rows of traps were set at 5 m intervals (20 or 40 on each side of the road). When sampling beach strand habitat, 20 traps were set at the *Pemphis*/beach interface at 5 m intervals. Trapping was conducted between 0600 and 1200 h and trap lines were walked every 15 min.

RESULTS

Night surveys for geckos totalled 7 man-hours. During this period, 340 geckos were sighted or collected. Mean number of geckos encountered per hour was 48.6. Species compositions of these gekkonids, expressed as a percentage of the total, are *G. oceanica* (6.2), *G. mutilata* (0.0), *P. ateles* (4.5), *L. lugubris* (0.6), and *H. frenatus* (88.8).

Arboreal skinks (*C. poecilopleurus*) were visually sampled or manually collected. Total time expended was 7.55 man-hours for a total of 343 *C. poecilopleurus*. Mean number of lizards encountered per hour was 45.4.

The forested habitat was sampled by the use of 'sticky' traps for a total of 955 trap-hours yielding 199 lizards. Mean catch per trap-hour was 0.21 lizards. Species compositions, as expressed as a percentage of the total, are *Emoia slevini* (2), *E. cyanura* (10), *E. caeruleocauda* (31.6), and *C. cf. fusca* (56.3).

The beach strand habitat was sampled by the use of 'sticky' traps for a total of 253 trap-hours yielding 65 lizards. These data should be broken into pre- and post-typhoon trapping as there were marked differences in trap yields. Pre-typhoon trap-hours were 168, yielding 61 lizards, or a mean catch rate per trap-hour of 0.36 lizards. Post-typhoon trap-hours were 85, yielding 4 lizards, or a mean catch rate per trap-hour of 0.05 lizards. For the pre-typhoon trapping, in terms of species composition expressed as a percentage of the total, *E. atrocostata* was 83.6 and *C. cf. fusca* 16.4.

DISCUSSION

Cocos Island presents a unique opportunity to look at what the herpetofauna of Guam resembled prior to the introduction of *B. irregularis*. Although the evidence is somewhat anecdotal, available data suggest that both *P. ateles* and *G. oceanica* were eliminated from Guam by predation from the brown tree snake (G. Rodda, pers. comm.). Other evidence suggests that *C. poecilopleurus* is rarely sympatric with *B. irregularis* in the native range, indicating some level of predation (G. Rodda, pers. comm.). The absence of the former species (formerly on Guam) and the presence of the latter species on Guam suggest that this phenomenon has also occurred on Guam. *Emoia cyanura* formerly occurred on Guam (Kami, et al., 1974) but is now restricted to Cocos Island in the Marianas. The absence of *E. atrocostata* on Guam is inexplicable. The species also occurs on Rota and the most parsimonious explanation would be that it has been extirpated from Guam because of environmental reasons. *Emoia atrocostata* is a habitat specialist living in areas that are subject to overwash from high wave action. The severe population reduction on Cocos Island following Typhoon Russ indicates that this species might be susceptible to local extinctions. *Emoia slevini* was last recorded on Guam in 1945 (G. Rodda, pers. comm.) and now appears to be found only on Cocos and the extreme Northern Mariana Islands. Its absence from Guam may be due to factors other than *B. irregularis*.

The above differences in the herpetofaunas of Cocos and Guam Islands indicate that there have been substantial changes in species composition. It is the differences caused by *B. irregularis* predation that may have resulted in profound shifts in the species compositions of the lizard community on Guam, particularly in the nocturnal gekkonid community. The obvious and immediate change is the removal of two conspicuous species (*G. oceanica* and *P. ateles*). However, it is possible that these two large lizards played a controlling role in the community structure of gekkonids and removal resulted in secondary shifts in the remaining species. Sabbath (1981) painted a different herpetological portrait of Guam in 1969-1970 and found *H. frenatus*, *L. lugubris*, and *G. mutilata* to form 66.5, 28.6, and 4.6%, respectively, of the gekkonid population in urban situations (n = 349). These figures should be compared to those presented above for an urban area on Cocos. In contrast to both of these compositions, an urban area on Guam for 1989-1990 had a species composition for *L. lugubris*, *H. frenatus*, and *G. mutilata* of 55.9, 29, and 15.1%, respectively (n = 238). This latter site had no *G. oceanica* and *P. ateles*. The absence of the latter species may have allowed both *L. lugubris* and *G. mutilata* populations to increase in urban situations, which may have, in turn, caused *H. frenatus* populations to decline. The high population levels of *H. frenatus* in the presence of *G. oceanica* may

indicate a resilience to predation by *G. oceanica*. Concurrently, the latter species depressed the population levels of *L. lugubris* and *G. mutilata*.

The changes in the diurnal lizard fauna (skinks) are more problematical to interpret. This is because of the addition of *C. cf. fusca* to the fauna. It is probable that since the introduction of this species in the 1950's, a certain amount of displacement of native scincids has occurred. For example, mean catch rate per trap hour on Cocos Island was 0.21 lizards and on Rota Island (currently *Carlia*-free), 0.32 lizards. Importantly though, all the lizards caught on Rota were *E. caeruleocauda*. This indicates that substantially higher densities of *E. caeruleocauda* occur in an area that remains *Carlia*-free. However, the absence of *E. cyanura* and *E. slevini* on other islands in the Southern Marianas make interpreting the definite roles of *Carlia* and other skinks on Cocos Island currently untestable.

There is ample evidence that indicates that the most abundant skink on Guam and Cocos Islands is *C. cf. fusca*. In terms of percent occurrence as a prey item in *B. irregularis*, *C. cf. fusca* is also the most abundant skink species. Analyses continue on the biological profile of *C. cf. fusca*. These data may allow the construction of a testable hypothesis on why this species supplants segments of the native skink fauna.

Biological Plasticity in *Varanus indicus*

BACKGROUND

The mangrove monitor (*Varanus indicus*) has a range encompassing extreme northern Australia, New Guinea, and the Solomon, Palau, Marshall, Caroline, and Mariana Islands. Evidence indicates that populations in the Caroline (Uchida, 1966) and Marshall Islands were recently introduced while those in the Marianas (G. Rodda, pers. comm.) may have been introduced by the original human colonizers several thousand years ago. In the Mariana archipelago, *V. indicus* probably occurs on all islands except the northernmost three (G. Rodda, pers. comm.).

The best-studied population occurs on Guam where feeding habits (Dryden, 1965), reproductive ecology (Wikramanayake and Dryden, 1988), and reproductive behavior (McCoid and Hensley, 1991) have been described.

The mangrove monitor has been introduced to islands for biological control of rats (Uchida, 1966). This attempt failed because monitors preyed primarily on small lizards and crabs and rarely on rats. After the introduction of the monitors, crab densities declined and the introduction of the marine toad (*Bufo marinus*) was considered to control the monitor populations (Uchida, 1966). Both Dryden (1965) and Thyssen (1988) have indicated that the presence of *B. marinus* has adversely affected *V. indicus* populations. The fact that *V. indicus* will consume small vertebrates other than lizards, albeit poisonous, indicates that a potential exists for a limited biological control of *B. irregularis*.

MATERIALS and METHODS

Both road kills and recently killed individuals were used for this study. Between 1989 and 1990, road-killed specimens were salvaged from Rota and frozen for analysis (n = 18). Between 1989 and 1990, road-killed specimens were salvaged from Guam and frozen for analysis (n = 4). Additionally, data on specimens killed in the mid-1980's were incorporated into this study (n = 4).

All specimens were thawed and necropsied. Snout-vent length and total weight were measured and stomach contents were identified to the lowest possible taxonomic level. Additionally, for future studies, abdominal fat bodies were weighed and reproductive condition recorded.

RESULTS

The results of the stomach analyses are presented below in Table 1.

Table 1. Stomach Contents of *Varanus indicus* from Rota and Guam Islands.

PREY CATEGORIES	PERCENT OCCURRENCE	
	1962 - 64†	1989 - 91†
Arthropods	28.0	45.5
Crabs	9.0	13.6
African Snails	16.6	0.0
Earthworms	9.0	0.0
Slugs	7.6	0.0
Lizards	1.3	13.6
Lizard Eggs	1.3	9.1
Hemidactylus	1.3	4.5
Ramphotyphlops	1.3	4.5
Rattus	11.0	9.1
Suncus	9.0	0.0
Wild Bird Eggs	3.8	0.0
Domestic Chicken Eggs	0.0	4.5††
Garbage	0.0	9.1††
<i>Boiga</i>	0.0	4.5

† After Dryden 1965

†† Not included in calculations.

DISCUSSION

The literature indicates that *V. indicus* is an opportunistic predator that incorporates small vertebrates in its diet, when available (Losos and Greene, 1988). These authors were also able to discern a geographic component to vertebrate consumption, but were unable to identify a reason, including prey availability, for this variation. The data presented in Table 1 and below indicates both a temporal and spatial role in the diet of *V. indicus* in the southern Mariana Islands.

A total of 26 monitor lizards were analyzed. Of those, 23 were collected in non-urban situations similar to conditions under which the monitors were collected by Dryden (1965). Dryden's monitors were collected primarily from Northwest Field on Guam in the early 1960's and represent a population that was not affected by substantial urban encroachment. Three specimens were not included in this analysis and had both human garbage (aluminum butter wrappers and squid) and domesticated chicken eggs as stomach contents, indicating some association with human activities.

A comparison of stomach content data obtained by Dryden (1965) and recent Guam/Rota data shows that there has been a shift in percent occurrence of prey items (Table 1.). Five prey categories are missing from recent data (African snails, shrews, earthworms, slugs, and wild bird eggs). With the exception of one category, all these are either rare or

unavailable on Guam and Rota. African snails (*Achatina fulica*) were seriously impacted by the introduction of a predaceous flatworm (*Platydemus manokwari*) (see Takeuchi and Kayano, 1991). Slugs may have been impacted by the introduction of *B. marinus*. Shrews (*Suncus murinus*) are absent from Rota and have been heavily impacted by *B. irregularis* predation on Guam (pers. obs.). The wild bird eggs recorded by Dryden (1965) were identified as *Rallus owstoni*, a species that is not established on Rota (R. Beck, pers. comm.) and now extinct on Guam. The reason for the absence of earthworms in recent data is unknown, although Losos and Greene (1988) did not record these as prey items either. These categories have apparently been supplanted by an increased reliance on other prey categories (Table 1). Arthropods still form the most common prey item and there has been an increase in the use of diurnal lizards (skinks) and their eggs. A new prey class that has appeared is *B. irregularis*.

The brown tree snake made its earliest appearance in Northwest Field on Andersen Air Force Base in 1968, although the species had been present on Guam since the late 1940's (Fritts, 1988). Since that time, the snake has spread island-wide and achieved high densities (Rodda and Fritts, 1991). Despite recent sightings of *B. irregularis* in the southern Marianas, exclusive of Guam, (McCoid and Stinson, 1991), no established populations are known.

The shift through time from items recorded by Dryden (1965) to those recorded in this study, indicate a temporal component to the feeding ecology of *V. indicus*. Additionally, prey items now found on Guam and not on Rota (*B. irregularis*) indicate a spatial component to the feeding ecology. These temporal and spatial factors reveal a foraging plasticity that may allow *V. indicus* to be exploited as a biological control agent for *B. irregularis*. Because many of the larger vertebrate (birds and small mammals) prey items have been extirpated from Guam by *B. irregularis* predation, *V. indicus* may be 'forced' to prey on more available vertebrate prey. Besides the single occurrence of a *B. irregularis* as a prey item (Table 1), other incidents are known. Both Gary Wiles [DAWR (pers. comm.)] and Manuel Santana-Bendix [Arizona Coop. Fish Wildl. Res. Unit (pers. comm.)] have observed *V. indicus* preying on *B. irregularis*. Observations of captive *V. indicus* indicate that even recently captured individuals from Guam will readily accept live *B. irregularis* as food. This suggests a familiarity with the snake as a prey item.

Other vertebrates on Guam are known to prey on *B. irregularis* (Conry, 1989). However, *V. indicus* is known to forage from the ground to high in vegetation, potentially exploring the gamut of diurnal resting sites for *B. irregularis*. This foraging tactic, coupled with the above plasticity in feeding ecology, allows the monitor lizard to be the most effective biological control agent currently in place on Guam.

Summary of *B. irregularis* Bite Data

BACKGROUND

Since the realization that *B. irregularis* poses risks to humans from envenomation due to bites (Fritts, 1988; Fritts, et al., 1990), efforts have been made by several agencies on Guam (DAWR and Public Health and Social Services) and the U. S. Fish & Wildlife Service (USFWS) to document the extent of this impact. Fritts, et al. (1990) showed that the segments of the population most at risk from envenomation were infants and very young children. They also showed that because of the seasonal activity patterns of the snake, bites were more likely to happen throughout the rainy season. Preliminary results of these topics were presented by McCoid (1990).

MATERIALS and METHODS

A questionnaire was developed by the USFWS, DAWR, and Guam Public Health and Social Services to assess the impact of *B. irregularis* on bite victims. A supposition was that all bites reported to medical facilities on Guam were being reported via the questionnaire. This questionnaire was designed so responses could be encoded for ease of interpretation. The categories of data collected included date of bite, age of victim, amount of pain, discoloration, and swelling associated with the bite, degree of respiratory difficulties, number of bites, site of bite, did snake hold at bite?, activity of victim at bite, size of snake, and time of bite.

RESULTS

A total of 80 questionnaires were returned to DAWR from medical facilities on Guam between September 1989 and September 1991. The distribution of bites by date is similar to that presented in McCoid (1990) and shows that bites reported tend to be clumped in the rainy season (June through December). The mean age of a bite victim was 16.8 years (SE 2.136) and the range was one week to 78 years. A histogram of all bite victims by age is presented in Figure 1. Of the 80 bites, 23 (29%) of the victims were one year or less in

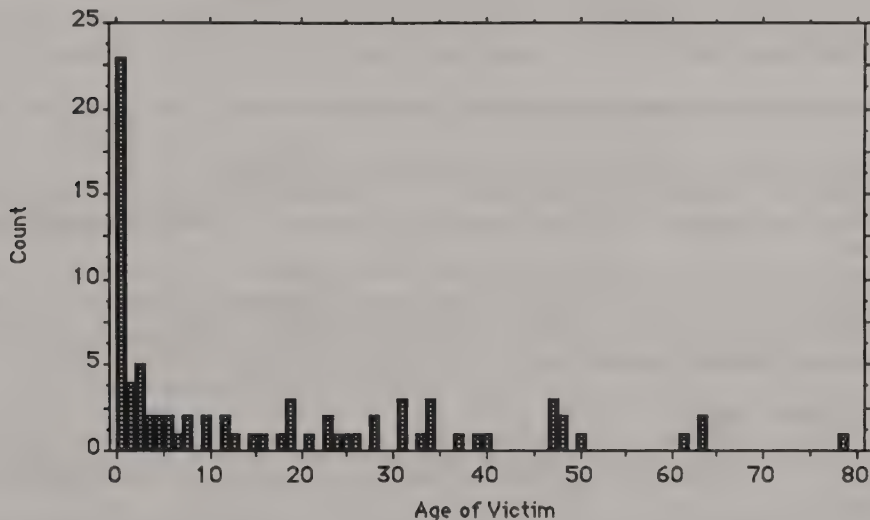


Figure 1. Snake bites on Guam as viewed by age of victim. Increments are in one year intervals. Data collected between September 1989 and September 1991. N = 80.

age. Bite victims six years or less in age comprised 47.5% of the total. Seventy-eight of the 80 questionnaires supplied information on pain, discoloration, swelling, and respiratory difficulties. Of those, 37 victims (47%) reported some pain associated with the bite. Two victims reported marked pain. Of the 78 bites, 33 (42%) reported some discoloration (ranging from redness to bruising) associated with the bite. Three victims reported marked discoloration. Of the 78 bites, 34 (44%) reported some degree of swelling associated with the bite. Six victims reported marked swelling at the site of the bite, some of up to 2X normal dimensions. Four victims had severe respiratory reactions that required hospitalization (all were under four months of age). Of the 80 questionnaires, 75

respondents reported the number of bites inflicted by the snake. Of those, 17 (23%) reported multiple bites (up to four). Only 69 of the 80 recorded if the snake held on during the incident; of these, 31 (45%) reported that the snake held on. Activity at the time of the bite was recorded for 72 victims. Of those, 59 (82%) were sleeping. Approximately 61% of the sleeping victims were six or less years in age. Of the sleeping victims that the site of the bite was known (52), 27 (52%) were on the fingers or hands. Other bite sites were arms, faces, heads, feet, and torsos. Size of the attacking snake was recorded in 59 cases yielding a mean total length of 1.0 m. Time of the bite indicated that in all cases, except one, attacks were between dusk and dawn. The exception occurred at 1545 h on a one-year-old infant in a house.

DISCUSSION

The trends mentioned by McCoid (1990) and Fritts, et al. (1990) regarding bites by *B. irregularis* on Guam continue. Extensive discussion of the above data and possible interpretations will be presented in Fritts, et al., MS. However, it appears safe to conclude that *B. irregularis* selectively bites victims that are less than a year old. The rationale behind this conclusion is simple. There is almost a four-fold decrease in the number of bites recorded for individuals between one and two years of age as compared to victims less than one year of age. It is highly unlikely that parents are less apt to bring in an infant 1.5 years of age versus 10 months of age for treatment of a snakebite.

RECOMMENDATIONS

1. Continue biological investigations of *B. irregularis* on Guam.
2. Continue biological investigations of the lizard fauna of Guam.
3. Afford some degree of legal and biological protection to *V. indicus* populations on Guam.
4. Begin an intensive public awareness campaign to minimize the risks of encounters with *B. irregularis*. This may take the form of a poster to inform local residents on how to 'snake-proof' a dwelling.

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Report Prepared By: Michael James McCoid

**JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO: E-1-6

STUDY NO: 7

JOB NO: 2

JOB TITLE: Movements, Home Range and Activity Patterns of the Brown Tree Snake

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

No significant effort was expended on this job during this segment.

Report prepared by: Michael James McCoid

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: E-1-6

STUDY NO: 7

JOB NO: 3

JOB TITLE: Development and Testing of Control Methods for the Brown Tree Snake

PERIOD COVERED: October 1, 1990 to September 30, 1991

SUMMARY

Three studies were undertaken during FY91. These were: (1) the use of economical devices to intercept snakes and the use of highly odiferous scents to attract snakes to these devices; (2) the reliability of a product currently marketed as a potent "snake repellent" (two studies); and, (3) the use of an electrical and mechanical barrier to protect nesting Mariana Crows from predation by brown tree snakes and mangrove monitors.

BACKGROUND

The brown tree snake (*B. irregularis*) has a native range encompassing northern Australia, New Guinea, and the Solomon Islands westward to Sulawesi. In the late 1940's, *B. irregularis* was unintentionally introduced on Guam (Fritts, 1988), an island in the Mariana archipelago roughly equidistant between New Guinea and Japan. Since that time, populations on Guam have reached substantial densities that may approach 100 snakes/hectare in certain localities (Rodda and Fritts, 1991). Coupled with the species' normal behaviors of nocturnality and arboreality, the phenomenon of high population density has directly or indirectly caused problems on Guam that span the spectra of difficulties associated with an introduction of a species. These problems include extinction, local extirpation, or substantial declines of vertebrate taxa (Conry, 1988; Savidge, 1986; 1987; G. Rodda, pers. comm.), electrical outages due to climbing behavior (Fritts, et al, 1987), human health risks due to bites (Fritts, et al., 1990), and predation of domesticated fowl (Fritts and McCoid, 1991). Since many of the avian and some of the reptilian insectivores and many of the avian seed dispersing frugivores and pollinators are now missing on Guam, it has been predicted that long-term changes in insect abundances and plant distributions should be expected (McCoid, 1991). Contractions in the distribution of a single species of plant on Guam has been causally linked to *B. irregularis* because of predation on seed-dispersing birds (Denton, et al., 1991).

Over the past decade, Guam has served as a source population for movements of *B. irregularis* to neighboring islands. Both civilian and military surface and air transportation have been implicated as vectors in these movements. Brown tree snakes have been reported on Saipan, Tinian, and Rota in the Mariana Islands, Pohnpei in the Caroline Islands, Oahu in the Hawaiian Islands, Kwajalein in the Marshall Islands, Wake Island, and Diego Garcia Atoll (Fritts, 1987; McCoid and Stinson, 1991).

In response to the above problems associated with *B. irregularis* infestation and continued movements to other extralimital islands, considerable energies have been allocated in developing technologies for control and containment of this species on Guam. Avenues of investigation have included trap design and configuration (Fritts, 1988; Rodda and Fritts,

1991), bait types (Fritts, et al., 1989; G. Rodda, pers. comm.), and development of mechanical and electrical barriers (E. Campbell, unpubl. data). Tests have also been conducted by the USDA to test the efficacy of a commercially available fumigant (methyl bromide) for use in cargo situations in inter-island shipping.

Attempts to develop adequate and effective means of protecting active nests of the Mariana Crow, *Corvus kubaryi* have been made. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of Tangle-Foot have all been used. The use of sheet metal girdles and Tangle-Foot have resulted in the mortality of trees and were discontinued. Clearing of vegetation and snake trapping have met with some success. Recently, electrical barriers were found to be effective in preventing brown tree snakes from climbing test poles (DAWR, 1990).

PROCEDURES

1. Field-test the durability of economical commercially available interdiction devices (rat snap traps) and the effectiveness of a series of odiferous baits (mammal scents).
2. Test the efficacy of a locally available 'snake repellent'. This was divided into two sections, each with a different experimental design.
3. Laboratory tests of the climbing ability on different surfaces were conducted.
4. Laboratory tests of alternative and effective means of controlling snakes were conducted.
5. Field tests of snake and monitor barriers on active crow nest trees.

RESULTS

Synopsis of Rat Snap Trap Experiment

BACKGROUND

Trapping experiments for *B. irregularis* have been conducted on Guam since 1984. The basic trap design has been a screen tube with one or more inverted cones on the ends allowing access to the interior (Fritts, 1988). Snakes captured in these traps could be retrieved alive and further use be made of them. During these trials, various baits were used, including bird feces, birds, bird eggs, geckos, mice, and inanimate objects in the form of small birds and mammals. A major assumption during more recently conducted trials is that odors have played a key role in attracting snakes to traps. This assumption was developed after the use of live homeotherm bait (quail and mice) because the highest snake catch rates were obtained with these bait types. Presumably, odor plumes from waste or body products were functioning as the attractant.

While homeotherm-baited traps generate high snake catch rates, they are very cost consumptive in terms of time and money to maintain. Because of these considerations, alternative methods of trapping snakes are being investigated.

MATERIALS and METHODS

Victor® standard snap rattraps were selected as an inexpensive alternative to the relatively expensive screen-wire funnel traps employed in earlier trapping experiments. A short

experiment indicated that these traps were effective in capturing snakes in a laboratory situation. Additional justification for these traps was that in control situations, it is not necessary to retain snakes alive. To entice snakes to approach the traps, four commercially available scents (Canine Distance Call, Coyote Food Scent Mast 5, SFE, and Mast 6), normally used by mammal trappers, were employed as bait odors.

Rat traps were modified by drilling a hole in each corner (for wiring to the substrate) and by lengthening the treadle by adding a partially straightened paperclip. This paperclip was taped to the treadle and would add greater surface area presumably increasing the likelihood of tripping the trap. Baits were prepared by adding a small amount of the scent to paraffin heated to melting in a double boiler. This slurry was thoroughly mixed and cotton swabs were dipped into it and then allowed to cool. The cotton swabs were then snipped off and a single swab was wedged into the bait platform of each trap. The four bait scents were coded as 1 to 4 and traps 1, 6, 11, etc. were baited with scent 1. Scent 2 was placed on traps 2, 7, 12, etc. Every fifth trap was a control and no bait was placed on the trap. Scents could be detected by nasal inspection up to two weeks after being placed on the traps.

One hundred and twenty traps were set at five meter intervals in a line extending between hunting areas 15 and 16 in Northwest Field, Andersen Air Force Base. The northern half of the trap line (61 traps) was set along a jeep trail in secondary typhoon forest dominated by *Leucaena* and *Scaevola*. Fifty-nine traps were set along the southern half of the trap line on the periphery of the old taxiway system. This area is also secondary growth with vegetation grading from *Scaevola* to *Casuarina* at the extreme southern end of the trap line.

Traps were set at approximately 1.5 m height and were oriented vertically except when vegetation did not allow this placement. Traps were checked daily between 0800 and 1000 h (although, during the study, traps were not checked on seven occasions, always over a weekend) at which time traps were reset or baits repositioned.

The experiment was conducted from 3 April 1991 to 17 May 1991. After 33 days, old baits were replaced with fresh baits in the same configuration as before. The trap line was checked for an additional 11 days at which time the experiment was terminated.

RESULTS

The experiment extended to 5280 trap-nights. This equates to 44 nights of trapping with 120 traps. There were 46 tripped traps recorded and only two of those captured prey (one *B. irregularis* and one *Rattus* sp.). The 46 trippings were recorded on 31 traps indicating that some traps were responsible for multiple trippings. Ten traps accounted for these multiple trippings, totalling 25 events (or, over half of the total tripping events). Two baits were lost during this experiment, but were later recovered by searching the ground adjacent to the traps.

DISCUSSION

Tripped traps did not appear to be randomly distributed along the trap line. Eight trip events were recorded on traps 5 through 9. Nine trip events were recorded on traps 32 through 39. Neither events were recorded on traps 10 through 28, nor on traps 40 through 64. Trap trips did not appear to be clumped from traps 65 through 120, except traps 81 through 86 where 13 trip events were recorded. If the northern (enclosed secondary forest) half of the trap line is compared to the southern (exposed secondary forest) half, differences can be noted in terms of the number of tripped traps. The northern half experienced 18 trap trips while the southern half experienced 28 trap trips. Multiple

tripping traps were recorded equally over the two halves (five traps in each). Five control traps were also tripped, two in the northern section and three in the southern section.

Considering the distribution of tripped traps and the differences in trap trips between northern and southern sections of the trap line, environmental effects may have played a role. The higher trip rate occurred in an open area with a north facing exposure to prevailing winds perhaps facilitating increased tripping due to swaying vegetation, etc. It is also possible that increased trip rates could occur in the southern section because of animal disturbance. For example, deer, pigs, and monitor lizards may range more freely on taxiways thereby increasing chances of encountering or being attracted to traps.

The discouraging factor in this experiment was the failure to trap *B. irregularis*. This can be viewed three ways: (1) *B. irregularis* are not readily trapped in snap traps. Laboratory tests indicated otherwise. (2) The bait was ineffective. This could be resolved by extensive, controlled laboratory testing. (3) *B. irregularis* densities are low in the study area and trap results are reflective of real densities. This could be resolved by night searches.

The encouraging factors in this experiment are that relatively few traps were tripped by environmental factors during the exercise and that no baits were lost from the traps. Traps that repeatedly tripped may have been more sensitive to disturbance and could be adjusted or repositioned as needed. This indicates that while the baits may be ineffective in attracting, the trapping and bait delivery hardware are stable.

Preliminary Testing of Snake-A-Way®

BACKGROUND

During the latter part of 1990, a product (Dr. T's Snake-A-Way®), self-described as a snake repellent, was introduced on Guam as an intended agent for localized control of *B. irregularis*. The product reportedly functions as an olfactory repellent with the active ingredients being naphthalene (7%) and sulphur (28%). The potential for this product on Guam is enormous and if effective, would be a valuable weapon in the arsenal against *B. irregularis*. Because the product was tested against a number species of snakes not found on Guam (H. Lillywhite, unpubl. rep.), conclusive testing of the effectiveness of this product on *B. irregularis* was initiated.

Between 4 and 14 December 1990, a series of preliminary tests were conducted at DAWR facilities, Mangilao, Guam to evaluate the efficacy of the snake exclusion product, Dr. T's Snake-A-Way®.

MATERIALS and METHODS

Two experimental designs for testing were selected to test the efficacy of Dr. T's Snake-A-Way®. In both experiments, the product was applied according to manufacturer's specifications and a local pest control operator's advice (J. Lopez, pers. comm.). The first was a circular enclosure which was 2 m in diameter surrounded by a 1.2 m high 1/4" mesh hardware cloth. One quarter of the circumference of the enclosure was covered by a 6" width broadcast layer of the product (Figure 1a). For scoring purposes, the enclosure was divided into quarters by inscribing the substrate (crushed coral) with a stick.

Snakes were released in the middle of the enclosure and the presence or absence in each of the quarters that was recorded. For analysis, the entrance of a test snake's head followed by the remainder its' body was defined as an 'active entrance'. Only the outer 2/3 of each quarter (Figure 1a) was considered the scoring area. Experimental replicates lasted between 7 and 12 min. If the snake scaled the fence during a replicate, testing was terminated and reinitiated with the same snake being reintroduced into the center of the enclosure. If a test snake failed to move in the test enclosure after 30 min, it was removed and subsequently reintroduced to the enclosure.

The second experimental design was a 6-m-diameter circle in a grassy lawn. The circle's edge was described a mowed swath approximately 15" in width (Figure 1b). Within the mowed swath, a 12" broadcast band of the product was applied.

Snake behavior was evaluated by timing the amount of time it took a snake after introduction to the center of the circle to encounter with the product barrier, whether crossing occurred, and reactions at the product barrier. If the snake remained quiescent for 30 to 60 min, it was removed and reintroduced to the center of the circle.

After the introduction of a test snake to test enclosures, experimenters observed snake reactions to the product at a distance where it was hoped observer presence would not bias snake behavior.

All tests were conducted after dark between 1830 and 2130 h. Weather conditions encountered during testing varied from cloudy to clear, and the mean air temperature during testing was 25.85 C.

RESULTS

Three snakes (mean SVL 1704 mm) were used for the first experiment for a total of twelve repetitions (173 min total). Two snakes underwent five test repetitions each and the third was tested twice (Table 1).

Table 1. Results of 2 m enclosure tests.

Quarter Number	1†	2	3	4
Pooled Entries††	10	10	9	10

† Quarter with "Snake A-Way".

†† Twelve repetitions, using 3 snakes.

In the second experiment (Table 2), four snakes (mean SVL 819 mm) were tested for five trials with 33 repetitions (378 min total).

Table 2. Pooled results of 6 m diameter test plot.

TRIAL SNAKE #'s	# Repetitions	# Crossed Product†	# Did Not Cross Product††
1	3	2	1
2	10	10	0
1	10	10	0
3	5	4	1
4	5	3	2

- † Of these trials, 21 repetitions hesitated at the product boundary, but still crossed and 8 showed no hesitation
- †† Of these trials, 1 snake was lost in the grass on the test plot prior to encountering the product. One snake was lost on the test plot after turning away from the boundary and 1 snake twice remained quiescent after being introduced to the study plot.

DISCUSSION

No difference was seen in the snake presence/absence (experiment 1) in areas where Snake-A-Way® was applied indicating that the snakes did not respond to the presence of the product. During one repetition, a snake remained quiescent with its head lying on the product for 31 minutes until disturbed by DAWR personnel. In the second experiment, of the 33 trials, only once was a snake observed moving away from the product barrier. Unfortunately, this snake was lost on the test plot and it is unknown if the snake eventually crossed the product barrier. However, this individual did cross the product barrier four times earlier in the evening.

From these results, it may be that Dr. T's Snake-A-Way® has low or no efficacy for repelling the brown tree snake (*B. irregularis*). Further testing is being conducted to evaluate the efficacy of this product using different experimental designs (see below).

Final Snake-A-Way® Testing

BACKGROUND

Since the above testing procedures were preliminary and intended only to explore the potential use of this snake repellent, additional testing was necessary. Potential flaws in experimental design and the results obtained in the above procedures dictated that more conclusive data be accumulated. See above for additional background information.

MATERIALS and METHODS

To test the efficiency of Snake-A-Way® as a brown tree snake repellent, a testing enclosure was constructed at the Department of Agriculture facilities in Mangilao, Guam. Dimensions of the enclosure were 68.5 cm width X 71 cm height X 249 cm length. The long sides and bottom of the enclosure were galvanized sheet metal, while the ends and top were wood-framed 1/4" mesh hardware cloth. One-half of the top was a hinged door facilitating entry to the enclosure. On each end of the test enclosure was a snake trap (63 cm length X 23 cm diameter) constructed according to Fritts (1988). The single funnel entrance to the trap was fitted with a flap to prevent escape once the trap was entered. Traps and flaps were constructed of 1/8" mesh plastic screen.

The bottom of the enclosure was uniformly covered with approximately 1.5 cm of sand (crushed coral). An approximately 30 cm band of the product was applied to the surface of the sand directly in front of the entrance to one of the traps, according to directions from a trained pest control operator (J. Lopez, pers. comm.). The odor of the product was checked regularly to ensure the presumed odor barrier remained present during the duration of the test; a faint odor was present at the conclusion of the test. The product barrier was not renewed during the test because the life expectancy of the applied product is at least several weeks, if not several months (H. Lillywhite, unpubl. rep.). The test enclosure was placed beneath a covered porch to prevent the degrading effects of rainfall and sunlight (H. Lillywhite, unpubl. rep.).

The following procedures were used to test the Snake-A-Way® product. Forty *B. irregularis* (mean snout-vent length 803 mm, SE = 28) were hand-captured, individually marked by painting a unique number on their heads, placed in 20 gallon aquaria, and held in captivity for no longer than three weeks before being used for testing. Since *B. irregularis* is nocturnal, testing was conducted at night. For 40 evenings between 8 July and 25 August 1991, a single snake was randomly selected from the pool of snakes and tested. Between 1700 and 2100 hrs, a snake was removed from an aquarium, placed in a cloth bag (45 cm x 90 cm), which was then placed in the center of the test enclosure. Upon placement in the enclosure, the bag was opened and care taken not to overly disturb the snake. The snake was left in the enclosure overnight and scored the following morning. After 20 trials, the testing apparatus was rotated 180° to reduce the chance that snake movement was biased by environmental factors other than the Snake-A-Way® product. If a snake was found in the trap behind the band of the Snake-A-Way® product, then it was presumed that the product did not repel the animal. If the snake was found in the trap with no Snake-A-Way® product, then it suggested that the product influenced the animal's behavior. The proportion of snakes found in each trap was compared using Chi-square analysis.

RESULTS

The percentage of *B. irregularis* found in the trap behind the Snake-A-Way® product was similar to the percentage of snakes in the trap without Snake-A-Way® in front of it (50% in each, $X^2 = 0$, 1 df, $P = 1$, Table 3). No significant difference was seen in snake presence in either trap when trials were analyzed to determine if the direction of the trap placement influenced trap choice by study animals ($X^2 = 0$, 1 df, $P = 1$, Table 3). The percentage of snakes found in traps in each trial ($n = 20$, respectively) behind treated and untreated sand mirrored the overall results for the entire experiment (50% in each, $X^2 = 0$, 1 df, $P = 1$, Table 3).

Table 3. Presence of brown tree snakes in traps behind sand treated with "Snake A-Way" and untreated sand in a testing enclosure in Mangilao, Guam, from 8 July to 25 August 1991.

TEST	N	TREATED	UNTREATED
Total	40	20 (50)a	20 (50)a
1st Half	20	10 (50)b	10 (50)b
2nd Half	20	10 (50)b	10 (50)b

a,b $P=1$, Chi-Square Test

DISCUSSION

Dr. T's Snake-A-Way® has been tested in Florida against a number of snakes, not all of which were native North American species (H. Lillywhite, unpubl. rep.). Two types of testing protocols were used in the Florida tests ('Y' and 'circle' tests). A collective avoidance of Snake-A-Way®, using the 'Y' tests, of 83% for all species of snakes was recorded (H. Lillywhite, unpubl. rep.). The 'circle' tests were conducted with a subset of the total species but supported the findings of the 'Y' tests (H. Lillywhite, unpubl. rep.). These two test designs are similar to those created for the tests conducted on Guam (both preliminary tests and those presented in this paper). The 'circle' test is similar to the preliminary Snake-A-Way® tests conducted in December 1990. The 'Y' test is similar to our test presented here in that the test snake is given a choice of crossing or not crossing a

barrier of the product. However, our current test differs from the 'Y' test in that the snake is completely undisturbed (no observers are present) when making a choice and, once a trap is entered, no decision change is possible. By eliminating potential observer interference, and testing for position effects of traps (see above), some of these confounding effects may be eliminated. Presence of observers during the Florida tests allowed detailed observations of snake reactions to the product barrier (given that observer bias may have been present). Since observers were not present during our tests, an alternative situation was created to partially document snake movements during a trial. When snakes were of sufficient mass, tracks in the sand substrate in the enclosure were recorded to indicate movements in the test chamber. Six snakes left discernable crawling patterns in the sand substrate. Of those, five had entered the Snake-A-Way® product band and of those, three continued through the product barrier and entered the trap. Because of low sample sizes, these were not statistically tested, although one-half of the test animals, respectively, entered treated versus untreated traps.

It is important to realize that responses to testing of the Snake-A-Way® product in Florida did not fall cleanly along taxonomic lines of snakes tested. For example, most venomous species of snakes (Family Crotalidae) were repelled while cottonmouths (genus *Agkistrodon*, Family Crotalidae) were less repelled (H. Lillywhite, unpubl. rep.). In parallel, representatives of the Family Colubridae showed substantial disparities in response to Snake-A-Way®. Some species were repelled while other species showed low avoidance of the product (H. Lillywhite, unpubl. rep.). *Boiga irregularis* is also a member of the Colubridae so it may not be surprising that this species was not repelled by Snake-A-Way®. Behavioral studies of *B. irregularis* indicated that visual cues may be most important when the snake is foraging at night (Chiszar, et al., 1988a). Chiszar, et al. (1988b) examined the role of chemical cues and found that they played a secondary or opportunistic role to visual cues. Since snakes smell by using the tongue to transport olfactory cues to the vomeronasal organs, a measure of olfaction rate (hence, olfactory interest) can be estimated by counting tongue-flicks per unit time. Chiszar, et al. (1988a) found that tongue flick rates increased in the presence of visual cues and not olfactory cues. This phenomenon was further explored by Chiszar, et al. (1988b) and they found that tongue flick rates increased in the presence of visual and non-volatile cues and not in the presence of volatile (airborne) cues.

The brown tree snake does not respond to the presence of Dr. T's Snake-A-Way® and will readily cross a barrier of the product. This conclusion is supported by statistically demonstrating that snakes showed no preference in entering a treated versus untreated trap and observations that indicated that snakes will crawl in a barrier of the product. In light of previous behavioral investigations (Chiszar, et al. 1988a; 1988b), this conclusion is not surprising as the product is highly volatile (airborne odors) and *B. irregularis* has been demonstrated to not respond to volatile cues and be visually oriented.

Mechanical and Electrical Barrier Development

BACKGROUND

Roadside counts by the Guam DAWR have well documented the decline of the native forest birds of Guam (DAWR, 1974-1988). Studies by Conry (1988) and Savidge (1986, 1987) have indicated that predation by brown tree snake as the main cause of this decline.

Barrier

During FY90, it was determined that an electrical barrier energized by an electrical charger was effective in preventing snakes from climbing test poles (DAWR 1990). The energizer used in protecting crow nest trees was a 2.5 Joule, 9000V charger powered by a 12V DC Lead-Acid battery. The 5 opportunities (nests) to use the barrier during FY91 indicated that the charger set at 1/2 power delivered currents of 3.5-5.1KV and did not require a battery change for up to three weeks. Voltage level of 1KV was found sufficient to prevent snakes from climbing test poles (DAWR 1990). The voltage level depended on the quality of the ground and cleanliness of the line. Ants, spiders, geckos killed on the line and leaves that would fall on the line would cause a decrease in voltage of several hundred volts. However, foreign material caught on the line did not cause failure of the system. The number of barriers (trees) energized by the same charger had no effect on the level of the line voltage.

Laboratory tests indicated the electrical barrier was not effective in keeping monitor lizards, which also prey on crow nests (J. Guerrero, pers. comm.), from climbing up trees. A simple skirt, placed perpendicular to the trunk, around the nest tree was used to solve this problem. It was made of 1/2 in. hardware cloth, cut into 30 cm wide by 43 cm long sections, and supported by 8 cm (3 in.) or 10cm (4 in.) angle brackets. Each section was secured to the bracket and to adjacent panels by using tie wire. Cutting the hardware cloth into sections made it easy to construct the skirt according to the natural contours of the tree.

Preparation of Nest Trees

Protection of the nest tree involved clearing of vegetation within 3 m of the nest tree, placing barriers on the tree(s) to be protected and setting up snake funnel traps, baited with live mice, around the perimeter of the protected trees and one on the nest tree. To preserve the immediate ambient environment of the nest tree and nest (e.g., shade, temperature, perch sites, etc.), several trees adjacent to the nest tree may be also protected. Usually, a team of 4 people was needed to clear vegetation around the tree(s) and to erect the barrier, all of which took about 2-3 hours to complete.

Nest Trees

FY91 saw the first time use of an electrical barrier to prevent the predation of brown tree snakes on endangered Mariana Crow nests. Five crow nests were protected by the electrical/monitor barriers, of which one was abandoned soon after the barrier was erected on the nest tree, one was preyed upon 3 days after the barrier was placed on the tree, and three showed promising results. The abandoned nest was most likely mistaken for an active nest.

The first crow nest to be protected by the electrical/monitor barrier was placed on the nest tree (*Eleocarpus sphaericus*) on December 15, 1990, a day after the female had laid a single egg in Northwest Field. The nest remained active until December 21, 1991 when it was destroyed by a typhoon, which had passed just south of the island.

On January 28, 1991, the same pair re-nested 500m east of the previous nest in a *Tristoropsis* tree. Four trees were protected with the barrier, which included three trees immediately adjacent to the nest tree and the nest tree itself. Unfortunately, the nest was preyed on February 1, 1991. A snake was possibly in the tree prior to setting up the barrier or, upon evaluation of the site, a branch from a nearby unprotected tree may have come in contact with the nest tree when the wind blew, which may have provided a way for the snake to reach the nest.

After the loss of a second nest, this pair again was discovered renesting on March 11, 1991, in *Intsia bijuga*, approximately 30m north of the previous nest. Three trees were protected which included the nest tree, an *Eleocarpus* and *Pisonia grandis*. In addition to the barrier, snake funnel traps baited with live mice were placed around the perimeter of the nest tree (4) and 1 trap on the nest tree, 3m above the ground. This tree remained active and undisturbed by predators thirty days into the incubation period. On April 8, 1991, the nest was inspected and the egg was confirmed present and the birds were still actively incubating. However, with a 24 day incubation period (R.Beck, pers. comm.) the egg was most likely infertile.

On March 6, 1991 a second crow nest, in an *Eleocarpus*, was protected by the barrier in the Conventional Weapons Storage Area (CWSA). Two trees were protected (the nest tree and an adjacent *Eleocarpus*). Three snake funnel traps were placed around the perimeter of the trees and one on the nest tree approximately 3 m above the ground. The nest remained active beyond the incubation period. The nest was inspected and the egg confirmed present. However, the egg again was believed to be infertile. This egg was dumped out of the nest on about the 28th day of the incubation period.

The presence of predators at the CWSA nest was confirmed with the discovery of two snakes that were caught in traps set in the perimeter of the trees and one slimed mouse, indicating a snake predation attempt. No snakes were caught in the trap placed on the nest tree. Monitor lizards were seen frequently within the territory of the crows, however, no attempt was made to trap these animals.

Field testing of the electrical monitor lizard barrier indicated this method to be the most effective yet in preventing predation not only by snakes, but monitor lizards as well. The use of an electrical barrier is probably also effective in keeping rats (probably *Rattus rattus*) from preying on crow nests. Unfortunately, the passing of the storm during the crow breeding season (December 21, 1990) meant the elimination of many potential nest sites. Increased human activity in the Munitions Storage Area during the Middle East War also contributed to a reduction in the number of birds nesting during the breeding season. Further field testing in the next crow breeding season will determine the efficacy of this barrier in protecting nest sites and at the same time, reveal problems with the technique so that corrections can be made. Development of this method comes at a time when reproductive success of Mariana Crows is vital to insure the continued survival of this population; consequently, there is little time available for further evaluation and development.

RECOMMENDATIONS

1. Utilize mechanical and electrical exclusion devices to minimize predation on the remaining nests of the Mariana crow.
2. Test the attractiveness of the scents in a controlled laboratory setting. Too many variables may have affected the viability of these scents in the above experimental conditions. For example, nothing is known about the effects concentrations of the scents in the paraffin slurry may have on persistence in an experimental state.
3. Retain the notion of utilizing rat traps in interdiction situations.
4. Do not endorse or use Snake-A-Way® as a snake exclusion chemical.

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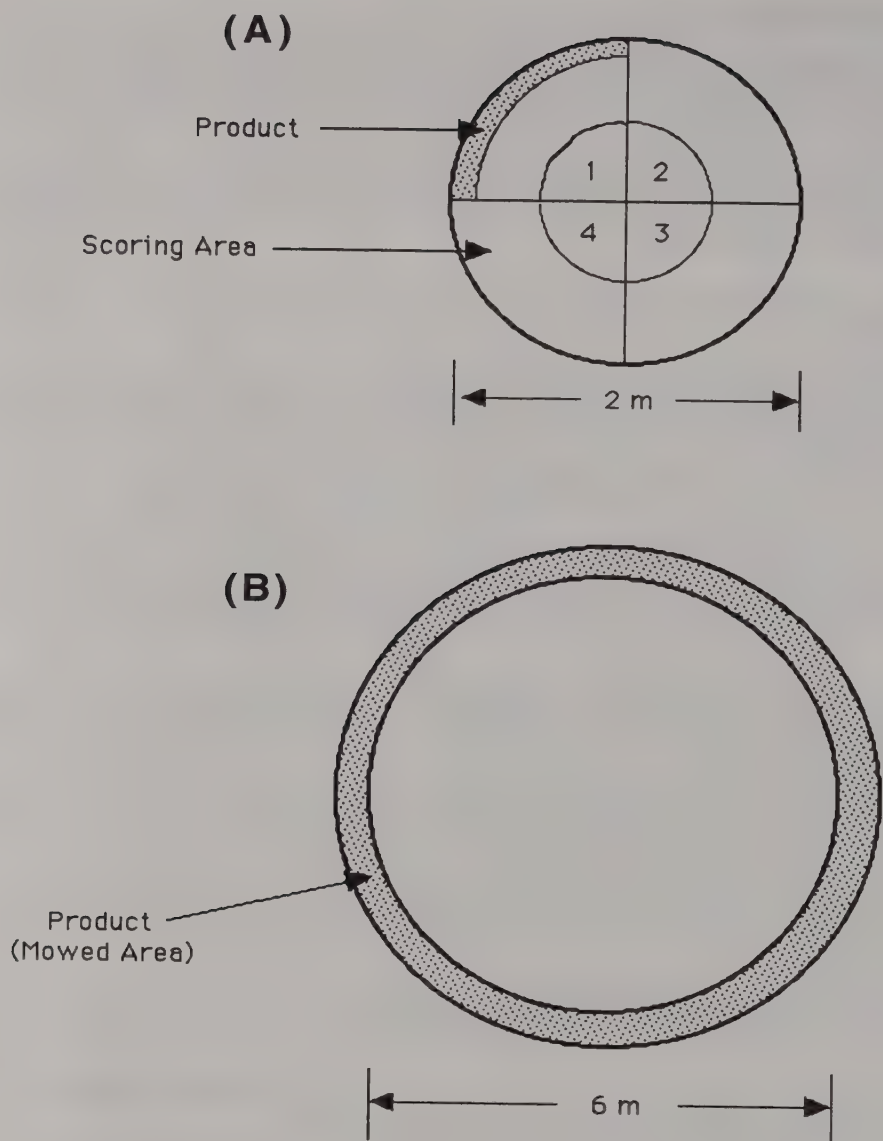


Figure 1. A. 2-m enclosure with quarters, scoring areas, and product area.
 B. 6-m test plot mowed area and zone product application.

LAW ENFORCEMENT

PERIOD COVERED: 1 October, 1990 to 30 September, 1991

During FY91, a total of 58 persons were arrested and charged for violating Fish, Game, Forestry and Conservation Laws. It is noteworthy to mention that 34 of the persons arrested were foreign nationals, and that three were U.S. citizens from off-island. These aliens and non-residents were primarily involved in violating the laws relative to harvesting of coral, trochus, and tree cutting on government land. A total of 19 individuals were arrested and charged for illegal hunting. These 19 arrestees include 2 minors, both male, age 9 and 11 years old, respectively. At the end of the reporting period only 4 individuals from 2 separate arrest cases had pleaded guilty. The defendants were sentenced to serve 5 days confinement (suspended) and to perform 150 hrs. of community service to be supervised by the Division of Aquatic & Wildlife Resources (DAWR), Department of Agriculture. In addition, the defendants were placed on probation for a period of 6 months. It was further ordered that all weapons and other paraphernalia confiscated from these individuals be forfeited to the Department of Agriculture for its disposition and that the total amount of \$600.00 paid by these defendants be made payable to the DAWR's Conservation Fund.

In addition, a judgement was rendered regarding an individual who had been booked and charged for an alleged illegal hunting violation during the late FY89. The defendant's counsel entered a motion on behalf of his client to change his plea of not guilty to that of guilty of the offense of unlawful use of an artificial light provided that the first and third offenses charged against the defendants, [1) illegal hunting; and, 3) possession of an unregistered firearm charged against the defendant be dismissed.] The court granted the motion and ordered that the defendant serve 5 days confinement (suspended) be placed on unsupervised probation for a period of one year, and pay a fine of \$500.00 plus court costs payable to the DAWR Conservation Fund.

Of the remaining persons arrested for illegal hunting, 2 individuals had the charges against them dismissed due to insufficient evidence. The remaining 13 individuals arrested for this offense were officially charged and referred to the AG's Prosecutor's Office for prosecution.

Of the 39 remaining arrestees, 6 were charged for violating wildlife import laws. Wildlife products intercepted by Guam Customs and Quarantine Officials included fruit bats, turtle meat, Micronesian pigeons, live clams and a live Python snake. These individuals were referred to our Division and after investigation, the individuals were arrested and written reports then submitted to the AG's Office for prosecution. The AG's Office subsequently referred certain of these cases to the U.S. Attorney's Office for their action.

Four individuals were arrested after they were seen cutting nigas tree along the shoreline, south of the Tanguisson Power Plant. The four individuals identified as aliens, pleaded no contest to cutting trees on Government of Guam land without a permit. Each paid \$1,000.00 to the DAWR's Conservation Fund, plus court costs.

Two persons were booked and charged after they were found in possession with 5 green sea turtles that they had hunted in the waters of Cetti and Umatac Bay. As a result of this arrest, a 4x4 Suzuki jeep, a 12 foot boat with an outboard engine and boat trailer, and assorted fishing paraphernalia were confiscated. At the end of the reporting period a forfeiture action against these articles was decided in favor of the Government and they

were forfeited to the Department of Agriculture's DAWR for its disposition. Criminal prosecution of the 2 suspects by the AG's Office is pending Prosecution.

A total of 27 persons were arrested for violating the coral harvest laws. On March 25, 1991, 2 individuals were caught taking hundreds of reef rocks (approximately 950 lbs.) along Alupang Cove reefline that had been inhabited by live corals. It was also learned that they (suspects) had shipped off approximately 2 tons of similar reef rocks to the Continental U.S. for sale to the aquarium trade. On September 27, 1991, both arrestees appeared in the Superior Court with their counsel to answer charges that were brought against them. Unfortunately, after several days of trial the jury found the two subjects not guilty and they were acquitted of all charges filed against them.

Four individuals were apprehended by a GPD patrolman near Tanguisson beach in possession of live corals and undersized Trochus. All four pleaded guilty and each paid a fine of \$1,070.00 plus court costs totalling to \$4,280.00, made payable to DAWR's Conservation Fund. A Mazda pickup truck was also seized in this particular case and has been forfeited to the Department of Agriculture's DAWR for its disposition.

In another case, 2 persons involved in illegal harvest of undersized trochus had pleaded no contest to the charges. Each of them paid a fine of \$900.00 plus court costs, with payment made payable to DAWR's Conservation Fund.

In yet another case, 3 persons were arrested for harvesting undersized Trochus and possession of live coral. One has already pleaded guilty and paid a fine of \$770.00 plus court costs. The remaining two individuals have requested to meet with the Magistrate at a later date.

Four persons caught for illegal taking of live corals at Cabras Island also pleaded guilty and paid a fine of \$500.00 each plus court costs. In addition, each was ordered to perform 100 hours of Community Service, which was converted at the rate of \$3.80 an hour. The fines and Community Service payments were made payable to DAWR's Conservation Fund.

Nine persons were caught illegally harvesting undersized trochus near the Piti Channel and Cabras Island. Two of the 9 arrestees pleaded no contest to the charges brought against them. One paid a fine of \$520.00 plus court costs and left the island due to an emergency reason.

On October 2, 1991, the remaining 8 individuals arrestees consummated a "Declaration of Civil Compromise," agreement with the AG's Prosecution Division. The agreement required a payment of \$4,500 payable to the Department of Agriculture's DAWR Conservation Fund.

A total of four persons arrested for violation of the coral and Trochus laws have their cases still pending before the courts.

At the end of the reporting period, we had a total of 2 vehicles (Suzuki jeeps) that were confiscated as evidence from individuals charged for violating Fish and Game Laws. Of the 2 vehicles, one was seized for illegally transporting deer carcasses taken out of season and the other vehicle was seized for transporting 5 live green sea turtles. Forfeiture actions were filed against these vehicles but to date only the vehicle involved in transporting the 5 live green sea turtles had been legally forfeited to the Department of Agriculture for its disposition. It is noteworthy to mention that along with the jeep that was forfeited to us for turtle poaching is a 12' boat with motor and boat trailer and miscellaneous swimming paraphernalia.

In addition 3 more vehicles that were seized for transporting deer carcasses out of deer season and several weapons and other hunting and fishing paraphernalia from 1989/90 cases were forfeited by court order to the Department for its disposition.

Numerous incidents, such as spotlighting, fish poisoning, fruit bat poaching and turtle hunting, were investigated by Conservation Officers that did not result in arrests. In some incidents, suspects were no longer in the area to be investigated and Officers may have made confrontations but no arrest made due to insufficient evidence and warnings were issued. Field investigation report of such incidents were submitted and filed for future reference.

On December 24, 1990, evidence from a total of 9 arrest cases stored in our evidence storage locker freezer consisting of deer carcasses, turtle meat, fruit bats, coconut crabs, animal entrails, undersized Trochus, and live corals, were disposed due to power failure caused by Typhoon Russ that took place Thursday, December 20, 1990. Prior to disposal of carcasses and perishable items, they were photographed and the photographs filed in the individual case files for future court reference.

In June and July, 1991, we recruited 7 new Conservation Officers (COs). Two are presently undergoing Police Academy School and will be graduating on January 24, 1992. Of the 7 new CO's, five are being trained on the job by field supervisors and Senior Officers. It is noteworthy to mention that these recruits have shown enthusiasm in their work, look professional and above all appear to be a very knowledgeable and intelligent group.

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